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POWER

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Power-Plant Opportunities

IN A recent foreword I admitted the narrowing outlook for the power plant operator who is no more than an operative, but maintained that there are bigger and better opportunities than ever for the real power engineer.

It has been said that we are passing from an age of steam power to an age of electric power, but for every kilowatt of electricity that is generated, a steam or hydraulic turbine or engine is furnishing the virility.

Electricity is working wonders as a means of transmission and distribution of power, but it has to have a prime mover behind it.

And electricity has made power so universally available and adaptable to so many new purposes, ingenuity applied to large-scale industrial operations has shifted so much from the workbench to power-operated machinery, discovery and invention have found so many products and purposes for which power is essential, that every year witnesses an enormous increase in the amount generated.

And with its growing importance comes the greater need to make it economically.

Consider the resources that a man who is given the problem of producing power and the related services that come from the power plant has at his command today as compared with those available a generation or two ago.

Consider the complexity of the modern plant as compared with the usual mill plant of a few years back and the higher qualifications of the man who can put it together and run it efficiently.

Consider the possibilities of high pressures and temperatures, back pressures higher than boiler pressures used to be, upon power as a byproduct from process steam.

The man who is alive to these things, who knows the possibilities of available apparatus and how to realize them, the man who can do what Fred Carter did at the Ingersoll Watch plant, as told in *Power* of September 18, has more chance than the man whose interest and responsibility ended with "keeping up the speed" ever had.

F. R. Low

POWER *Stands for . . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application

Cheaper Power Through Modern Equipment

IMAGINE the savings possible in the power plant by the installation of modern equipment to replace the obsolete or by the application of new design data in revamping existing equipment. Even in the best and newest plants there can generally be found place for equipment of more recent design, and it should be installed whenever the savings will offset the cost.

In this issue an article tells how a chief engineer applied the most recent data and modern practice to the design and reconstruction of the duct system between the boiler and stack in his plant. This resulted in a direct yearly saving of 400,000 kilowatt-hours. Of even greater value was the increase of 800 kilowatts in plant capacity, which in this case might be considered the equivalent of an investment of $40,000 in additional boiler capacity. These savings surpassed expectation and fully justified the change.

Undoubtedly there are many plants, both new and old, whose duct systems could be equally improved. The opportunities are there, and wait only for engineering thought and initiative to make them realities.

Where Durability Is a Curse

DURABILITY, in and of itself, is wholly good, but human shortsightedness may make it a curse. "This equipment is still in perfect operating condition" is made the excuse for continued inefficiency. When proof is offered that new boilers or turbines, or a more effective layout of process piping, would pay its cost in a short time, the specter of "good equipment junked" raises its head and frightens common sense away.

If the existing engine cost ten thousand dollars ten years ago and could probably keep on running another ten years, the owner sees a waste of five thousand dollars in junking it. So he continues to waste thousands of dollars in fuel and congratulates himself on his frugality.

Yet there is such a thing as spending to save. The wise business man does not hesitate to call a taxi when pressed for time. He knows the greater cost of wasted moments and opportunities let slip. The intelligent carpenter does not refuse to buy a ratchet bit stock because his grandfather's solid affair is good for another century of service. His time has value.

The starting point of all sound thinking on the subject of equipment investment is the realization that past decisions and purchases are water over the dam regardless of how they may be carried on the books. Each day we start from now. "What *new* investment is required," the practical economist asks, "and what *new* saving will it produce?" If the new saving warrants the new investment, action is justified. The sum originally paid for the equipment replaced has nothing to do with the matter.

Yet engineers, and even business men, have been known to throw the past on the scale pans when weighing future action. Such thinking is responsible for meager profits in many an industrial establishment.

Welding and the Power Services

WELDING has passed the period of slow development and is now sweeping into every branch of industry with resistless momentum. Its field is destined to be as broad as that of the use of metals.

More than fifty steel buildings and bridges have already been welded. Not one has failed. Most of the airplanes that have made history during the past two years have depended for safety upon numerous welded joints. The new Ford car contains several thousand welds and the welding process is extensively used by other automobile manufacturers. Thousands of miles of outdoor lines for gas, oil and city water have been welded and the process may soon dominate this field. Several manufacturers of electrical machinery are rapidly displacing castings with parts fabricated by welding from standard structural shapes and sheets. Similarly, welding has begun to take the place of riveted construction in fans and blowers.

In the power house welding is already used on fin boiler tubes, bunkers and hoppers for pulverized coal, airtight settings for boiler casings, stacks, coal and ash-handling machinery, tanks, feed-water and storage heaters, air and gas ducts, air preheaters, low-pressure boilers and general repair work. But the most important power-service application, in and out of the power house, is to piping. Lines for high-pressure and low-pressure steam, hot water, cold water, compressed air, atmospheric exhaust, condenser circulating water, brine, ammonia, oil and gas are all being welded successfully by the oxy-acetylene and arc processes. Experience with these welded lines has not justified early misgivings, except in a very few cases where the work was not properly supervised. Proper methods of inspection and procedure control have been established and are available to all interested, so there is no longer any excuse for poor work.

Welded lines are often cheaper in first cost and are

invariably superior in the matter of tightness. Changes are easily made with the aid of the cutting torch. On steam and refrigerating lines the elimination of flanged joints reduces the cost of insulation and cuts down heat losses appreciably.

The uses for welding on piping systems should justify a welding outfit in every plant. Once installed for pipe work, it will find innumerable other uses.

Spare Parts

TO WHAT extent one is justified in keeping on hand spare parts has always been an open question, influenced largely by geographical location and requirements of service. The problem has now become intensified by the rate at which practice is changing and improvements are being effected both in design and materials.

Spare parts may be regarded chiefly as an insurance against unduly long outages, although to some extent they may guard against failure where a part at hand can be slipped in during an inspection period or when the unit is temporarily off the load. The money tied up in such spares is usually regarded as well invested, especially when there is assurance that they will ultimately be used. But where ever-changing designs make it necessary to scrap these parts at frequent periods, it may be advisable to depend on securing spares from the manufacturer when needed, even at the risk of slight delay. Moreover, it is seldom desirable to replace a worn or broken part with one of like kind when an improved design is available.

Thus it would seem that the problem resolves into considering separately those classes of equipment that have become more or less standard and those that are in a state of flux.

Materials for Turbines

BLADING and other troubles, which still plague the operators of steam turbines, indicate that there remains room for considerable improvement in the design and construction of these machines. Noteworthy as have been the improvements made in the past, there is need for further advances. Turbine outages are an unalloyed drawback to economical operation of power plants, and their avoidance is ardently sought.

Two avenues of approach are open to those who seek to eliminate the present difficulties. Closer, more thorough analysis of the stresses set up in the machine under all possible conditions will serve as a guide to improved design. And the development and use of more suitable materials of construction—specifically, of better metals—will make possible the realization of design improvements.

It is in this field of metals for turbines that there is need for clearer thinking and, often, for education. The urge for low first cost is ill-advisedly pressed home by the purchaser. And the manufacturer, for this reason, is restructed in the metals he can use. Thus it comes about that the cost of the materials enters too greatly into their choice.

The power engineer must be brought to realize that losses due to impaired operation of his plant may cost many times what can possibly be saved on the first cost of his prime mover. And the plant may be crippled at the least opportune time. These two considerations should make him want to buy the best machine that can be built rather than the cheapest.

And the manufacturer will be working for the good of all concerned if he will insist upon using only the most suitable material, even if he must ask a higher price.

These conditions as to materials have existed for a long time, but have not attracted as much attention as might be. Today, however, with almost momentary increases in size, pressure and temperature, their importance is magnified. Structural troubles tend to seem more frequent and to cost more when they come. Correction of these troubles lies almost solely in the use of better materials—when, if and as available—and in a willingness to pay the necessary price.

Costs of Preparing Powdered Coal

AN ELEMENT in the use of powdered coal concerning which there appears to be much question is the cost of drying and pulverizing the coal. The first cost of pulverizing equipment may compare favorably with stokers, but the power requirements exceed those of the stokers and form an appreciable element in the total yearly cost.

More data on these preparation costs for various kinds of coal should be available by now, considering the number of installations in service and the fact that normal operation has been reached by this time. A distinct aid to the industry will be rendered by the collection and analysis of such costs. This is particularly desirable, for such items as maintenance are likely to be overlooked in the enthusiasm of planning for the use of powdered coal in small plants.

Many large stations have found it desirable to provide means for a certain amount of coal drying even with unit mills to insure uniformity of feed. This may be done by preheated air, but to what extent is this carried out in the small plant?

Furnaces in industrial plants are often built cheaply of refractories which will stand up only when large percentages of excess air are used. This excess air decreases boiler efficiency. Some so-called air-cooled furnaces built with hollow tile are of no particular value, as there is insufficient air circulation through these tiles to insure proper cooling when operating with low excess air.

Finally, adequate instruments must be provided in industrial plants if the fireman is to secure that additional efficiency necessary to offset the added cost of preparing his pulverized coal.

Co-ordinating a

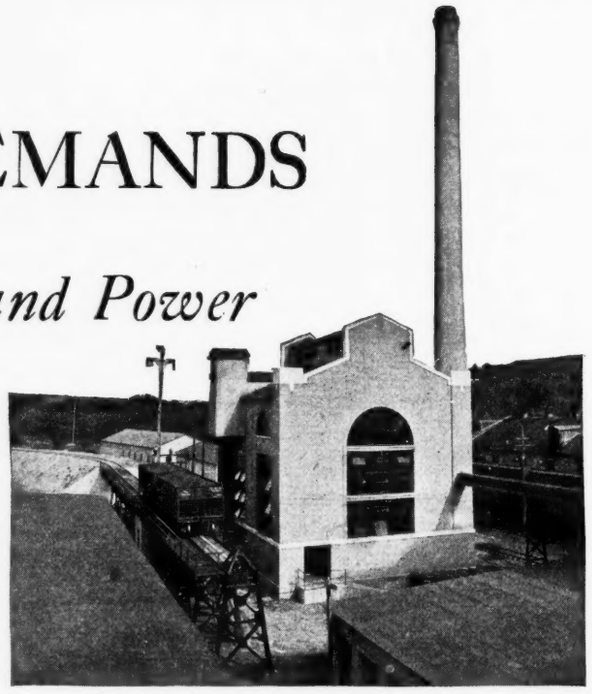
PAPER MILL'S DEMANDS

for Steam and Power

By J. C. Hayes* and O. C. Callow

Combustion Engineer, Freyn Engineering Company

Asst. Electrical Engineer, Freyn Engineering Company



Boiler house showing coal-handling facilities

SITUATED on the Wisconsin River at Brokaw, Wis., the plant of the Wausau Paper Mills Company has a nominal capacity of 130,000 lb. per 24 hours, of fiber, manilla, bond and kraft papers; 50,000 lb. of ground wood, and 110,000 lb. of sulphite fiber. The paper mills and auxiliaries were driven in part by waterwheels, in part by steam engines and in part by motors. Prior to the installation of a new boiler plant and hydro-station, direct-current generators driven by waterwheels supplied light and power to a number of auxiliaries and about 500 kw. of alternating-current power was purchased from the local utility. A 1,000-kw. steam turbine was installed several years ago as a stand-by source of power, but has been operated only for short intervals.

In the old boiler house were six two-pass boilers, each having 3,500 to 4,000 sq.ft. of surface and operating at 150 lb. pressure. Two of these boilers burned wood refuse from the mills in combination with purchased hog fuel. The other four boilers were equipped with stokers for burning coal. The steam generated was used in part for digesters and in part to supply engines running paper machines. The exhaust from these engines at 25 lb. pressure was used in paper drying rolls.

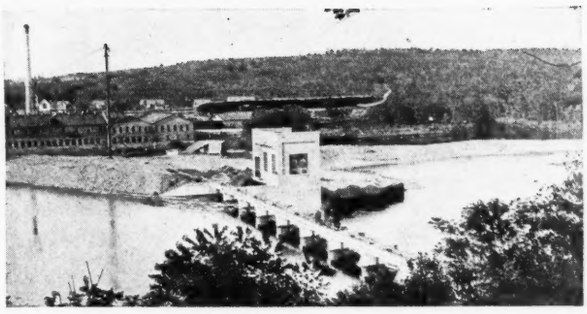
As some of the old boilers were of obsolete design and in view of relatively inferior operation from the remaining units, the question of more economical steam and power production was taken up. A study of the entire situation was made by the Freyn Engineering Company, in which several courses were considered.

In one arrangement the boilers were merely to be replaced by larger and more efficient units. In another, new high-pressure boilers were to be installed in combination with a turbine-generator equipped for bleeding steam to the digesters and to the mill engines, a small amount of steam passing to a condenser to insure a supply for the intermittent steam uses at all times. The steam balance was such that additional electric load would have been required in order that the steam input might be sufficient to meet the fluctuating demand for steam at reduced pressure for the engines and digesters.

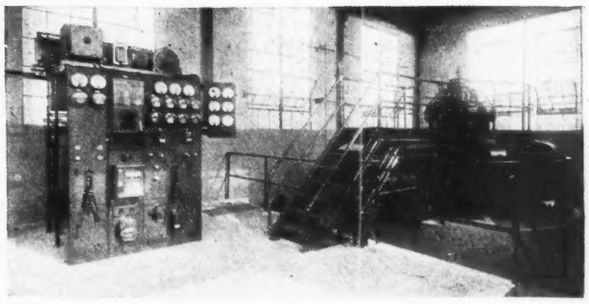
Potential water power in the Wisconsin River at Brokaw was investigated and also the efficiency with which this power could be utilized. As the existing waterwheels were obsolete, additional power development over a greater portion of the year offered attractive returns on the indicated investment. At a site on the existing dam it was decided to install a waterwheel of 1,420 hp. capacity, driving a 1,375-kva. three-phase 60-cycle 460-volt generator. This unit was to supply the motors that previously took power from the utility, as well as some additional motors replacing portions of the lineshaft drive from obsolete waterwheels and the energy required for lighting. Formerly, the lighting was obtained from a separate waterwheel generator which is now eliminated.

It was decided to install new high-pressure boilers, designed to take care of future developments, but to operate at 150 lb. for the present. Steam from these boilers is to be supplied to the present digesters and the paper-machine engines, exhausting at 25 lb. pressure to

A survey of conditions at the plant of the Wausau Paper Mills Company resulted in supplying power and light by a modern semi-automatic water-turbine unit with a steam-turbine generator in reserve. Pulverized-coal-fired boilers supply steam to this unit and to existing digesters and paper machine engines. Exhaust from these engines at 25-lb. pressure, supplemented by live steam at the same pressure generated from wood refuse, supplies the process demand.



Old dam site and new building housing hydro-electric station



Hydro-electric unit and semi-automatic switchboard controlling it

the paper drying rolls, and to operate the existing 1,000-kw. steam turbine during periods of low water, when the waterwheel cannot develop full capacity.

The new boiler house, recently completed, consists of a brick building 47 ft. 6 in. long by 51 ft. wide, containing two 5,120-sq.ft. water-tube boilers, built for 450 lb. working pressure and 150 deg. F. superheat. Sufficient space has been provided for the installation of a third boiler. The boilers are equipped with water screens and air-cooled side walls and arranged for pulverized-coal firing. There are three unit pulverizers, one being a spare to serve either or both boilers. Each pulverizer is designed to deliver 4,500 lb. of coal per hour and is driven by a 60-hp., 220-volt, alternating-current motor.

A steel trestle at the side of the boiler house, connecting with an elevated track, provides for incoming coal. Unloaded from railway cars into a track hopper, the fuel passes over a belt conveyor and magnetic separator pulley to a coal crusher, is elevated to the top of the boiler house by a bucket elevator and distributed into bins by means of a 14-in. screw conveyor.

The crushed coal is fed by gravity from the bins to the pulverizers, the feeders being operated by variable-speed direct-current, ¼-hp. motors with controllers regulated by a combustion-control system operating from the steam pressure. Secondary air for each boiler is supplied by a double-duplex motor-driven fan. A concrete stack 175 ft. high, serves the two boilers and is arranged to accommodate the future unit.

Neither economizers nor air heaters are installed, but secondary air is heated to about 150 deg. F. through the air-cooled side walls. Coal is crushed and pulverized as received. When it is necessary to use coal having more than 10 per cent moisture, partial drying is effected by drawing some of the hot furnace gases through the primary air inlets of the pulverizers.

Furnace draft is maintained at about 0.2 in. by automatic damper control. The combustion-control system consists of a master controller governing the speed of the disk coal feeders to the pulverizers and the position of the dampers in the secondary air ducts between the fans and the furnaces. When changes in the character of coal make it necessary, manual adjustment of the coal feed is made by screw control of the feeder hopper at each pulverizer.

PRINCIPAL EQUIPMENT AND MATERIALS USED IN HYDRO-ELECTRIC PLANT AND BOILER HOUSE OF WAUSAU PAPER MILLS COMPANY

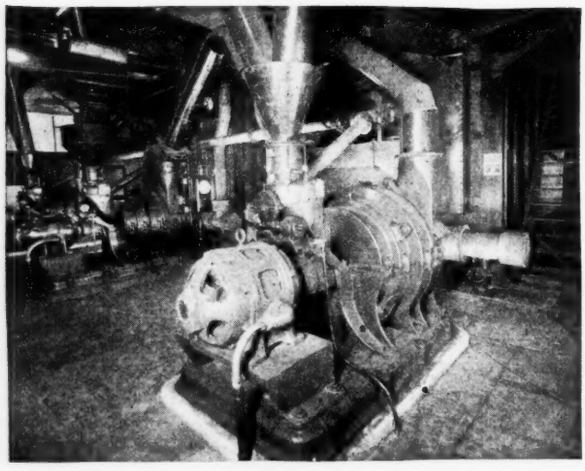
Boiler Plant

Boilers, two 5,120 sq.ft., 450 lb.	Springfield Boiler Co.
Pulverizers, three, 4,500 lb. of coal per hour each	Erie City Iron Works
Superheaters, two Foster convection type	Foster-Wheeler Corp.
Pump, one, 2-in., 4-stage, 140 g.p.m. against 460 ft. head	Worthington Pump & Machinery Corp.
Pump, one, duplex boiler feed, 108 g.p.m.	Worthington Pump & Machinery Corp.
Chimney, reinforced concrete, 175 ft. x 6 ft. 3-in.	The Heine Chimney Co.
Fans, forced draft	Buffalo Forge Co.
All motors for pulverizers, burner fans, coal crusher and feeder, elevator and screw drive, and boiler-feed pump, together with complete control equipment	Westinghouse Electric & Mfg. Co.
Automatic combustion control for boilers	A. W. Cash Co.
Soot blowers	The Vulcan Soot Cleaner Co.
Coal-handling system	D. J. Murray Mfg. Co.
Coal bunker gates and chutes	Beaumont Mfg. Co.
Pump governors and feed-water regulators, Copes	Northern Equipment Co.
Piping	Pittsburgh Piping & Equipment Co.
Valves, non-return	Schutte & Koerting Co.
Valves, steam and water	Chapman Valve Mfg. Co.
Boiler-feed meters, recording	Simplex Valve & Meter Co.
CO_2 recorders	The Jos. W. Hays Corp.
Flue-gas temperature recorders	Taylor Instrument Co.'s
Magnetic separator pulley	Dings Magnetic Separator Co.
Erection of boiler brickwork	O. H. Warwick Co.
Firebrick and special tile for boiler settings	Chicago Fire Brick Co.
Furnace side walls	M. H. Detrick Co.
Special tile	Walsh Fire Clay Products Co.
Insulating material	Johns-Manville, Inc.
Structural steel	Worden-Allen Co.

Hydro-electric Plant

Hydraulic turbine, vertical, one 1,420-hp., 100 r.p.m., 17.5 ft. head	S. Morgan Smith Co.
Generator, one, 1,375-kv., 1,100-kw., 1000 r.p.m., 3-phase 60-cycle, 460-volt; direct-connected, 6-kw., 125-volt exciter	General Electric Co.
Oil pressure governor, 16,300-ft.-lb. and motor-driven oil pump	Woodward Governor Co.
Air compressor, 15-cu.ft. per min., 100-lb., motor-driven	Woodward Governor Co.
Bearing water pump	Worthington Pump & Machinery Corp.
Hand-power crane, 20-ton	H. D. Conkey & Co.
Switchboards	Westinghouse Electric & Mfg. Co.
Storage battery	Electric Storage Battery Co.
Transformers	Westinghouse Electric & Mfg. Co.

Two of the old boilers have been retained in service to burn wood refuse consisting of bark and sawdust containing approximately 50 per cent moisture. This fuel is mostly hand fed to the dutch oven furnaces and burned by cone firing. The steam output from the refuse-fired boilers fluctuates, owing to the charging of wet fuel at regular intervals, regardless of steam demands of the plant, with the result that a corresponding intermittent demand for steam exists at the new boilers. While the influence of this intermittent steam demand is seen on the steam pressure, feed-water flow and, to some extent, on the waste-gas temperature, the combustion control system, aided by the quick response of the coal pulverizers and boilers to load changes, maintains remarkable uniformity in the CO_2 content of the waste gases at all loads. Over-all operating efficiencies of over 77 per cent are maintained, including week-end shutdown losses. In view of the intermittent load conditions, this performance is quite satisfactory.



Unit pulverizer installation

At the existing dam in a 28x48-ft. brick building having a 20-ton hand-operated crane installed for repair work, is the waterwheel, a vertical turbine rated at 1,420 hp. when operating under a head of 175 ft. Control is by means of an oil-pressure governor, operating steel-plate, balanced, wicket-type gates. A motor-driven pump maintains an oil pressure of 200 pounds.

A manually operated air brake is arranged to stop the wheel after the gates are closed, the compressed air being supplied by a small motor-driven compressor. The mainshaft bearing is of the lignum-vitæ type provided with a continuous supply of clean water. A 6-kw. 125-volt exciter is directly connected to the vertical generator. Connections from the generator to the switchboard are made by means of copper busbars, and from the feeder panels to the main distribution board in the mill building, lead-covered, varnished-cambric, three-conductor cables in a concrete duct run carry the energy.

This station is designed for semi-automatic operation. The machine is started and put on the line by an operator, after which no attendant is required. Protective relays, installed at all danger points, are arranged to trip the generator off the line and close the gates in case of trouble. An annunciator lockout relay indicates the cause of the shutdown.

The following protective devices are provided: Overspeed limit device, low-voltage relay, over-voltage relay, differential-current relays, over-current relay, bearing-thermal relay, oil-pressure-failure relay, and generator-thermal relays. The majority of these devices operate from a 24-volt direct-current control bus, supplied from a 12-cell storage battery provided with a trickle charger. Operation of any protective relay causes the governor trip coil to release, closing the gates and by operating the trip coil of the generator oil switch disconnecting the generator from the line. Provision is made for synchronizing the generator with the 1,000-kw. steam set for emergency service or in times of low water.

Placed in operation last April, this plant has been carrying loads around 900 kw. with good results.

A Gas Engine Explosion

By W. L. Warner
Brentford, England

A SERIOUS explosion took place in the crank chamber of a four-cylinder gas engine, working on Mond gas, this blowing off the sheet-metal casing, damaging the governor, and also the engine house. The engine was started on compressed air, which was supplied to two cylinders, this being sufficient to start the engine. The engine was being started and had begun to fire when the explosion occurred; the gas was immediately shut off and the explosion investigated. It was undoubtedly due to an explosive mixture in the crankcase.

The air for the cylinder charges was drawn from the engine room through passages in the cylinder casting. Ports connected these passageways with the four inclosed crank chambers, their purpose being to ventilate the crank chambers. The engine had been standing for some hours before this explosion occurred. It seems that gas had leaked past the main gas cock and via the mixing chamber into the air intake passages and then into the crank chambers, where it formed an explosive mixture, one or more of the air inlet valves being open connecting the mixing chamber to the passageways. Two slight explosions had occurred on previous occasions.

This method of supplying the intake air is not entirely satisfactory. The air should be drawn from suitable silencing boxes, preferably placed outside the engine room. Gas cocks, particularly the main gas cock, should be kept in good condition and leakproof; otherwise, if gas leaks by when the cock is shut, it may get into some place where it may cause a serious explosion.

Leaking gas is always a danger and can be guarded against only by keeping all cocks tight and in good condition.

Methods That Save Money

The Detroit Edison Company has made a study at its Beacon Street Station to determine the practical value of automatic combustion control as it can be applied in this company's plants. The verdict, to be published in *Power* next week, is in favor of automatic control.

How To *Suspend Fire-Tube Boilers Select the Brick Build the Furnace Walls*

By Burton W. Wheeler

CONSIDERABLE space has been given to the discussion of the different types of settings for water-tube boilers, but not much has been said of the return-tubular boiler. While there is a practical limit to both the size and pressure of this type, there is a large field in which it is the most economical boiler to buy. Furthermore, in spite of the present trend of steam generation, it will be sold in large numbers in the future as it has been in the past. This type of boiler, as a rule, does not receive as much consideration in the design and quality of its setting as it should. Wasteful settings have been a large factor in the shutting down of many plants.

It is the duty of the engineers to attack this problem and prevent waste in small plants as well as large ones. There must be some type of wall that is best for this type of boiler. Possibly some organizations have had the time and money to experiment with different types of settings and are willing to pass their experiences along.

Recently, we installed a 72-in. tubular boiler to take the place of one that was getting old. In removing the old boiler we also removed an old wrought-iron boiler of 54-in. diameter and of unknown age. These two and one other still in use, were originally in one battery. A sketch of the setting for the new boiler appears in the illustration. It was decided to make this a suspended type of setting with an overhanging front. I believe that the extra cost of the suspension is justified by the greater safety and better installation all around. The overhanging front does away with all possible chance of the extension sheet overheating and causing a leaky tube sheet.

The New Boiler Setting

The sketch shows that we have a single solid wall instead of the common hollow wall. A single wall is cheaper to build, and this is therefore a strong argument in its favor. Other things to consider are cracks in the walls and consequent air leakage. Owing to the expansion and contraction of the walls, cracks are made especially in the lining. If they run into an air space no harm is done so long as this space remains closed to the atmosphere, but you can never be absolutely sure that it is. On the other hand, if those cracks must come to the outside wall they can be found and the air leakage stopped. I think it is safe to say that 99 out of every 100 settings will show some cracks.

A single wall can be made stronger as well as cheaper than a double wall. Notice, in sections *AA* and *BB*, that the headers are put in at every fifth course and that they extend through the wall, one header overlapping the next. This gives a cantilever support to the lining by the outside bricks, instead of depending upon the already burned and weakened firebrick to support themselves. It will be noted by sections *CC* and *DD* that expansion joints are put in the walls on the ends as well as at the bridge wall. It was thought that this would prevent the wall from cracking. While it may have helped, the side walls cracked opposite the manhole, extending downward for a distance of about three feet. This setting was not fired for a month after the masons finished and then it was slow fired for over a week, so that I do not think that it was the fault of improper drying. These cracks followed the joints between the bricks, so all it was necessary to do was to chisel out the mortar and repoint.

Kinds of Joint Filler

Another argument might be developed on the question of the best kind of joint filler to use in laying the firebrick. There are two distinct kinds of filler, natural fireclay and prepared cement. Fireclay only fills the crevices between the bricks and, until it vitrifies, has no bonding strength. We used fireclay with the idea that our furnace would eventually need repairs and that the furnace temperature would not go above that which fireclay would withstand. A lining laid up with fireclay can be repaired by simply taking out the firebrick between the headers and replacing them with new. A prepared cement or high-temperature cement will bind the firebrick together and make a monolithic wall; it is almost impossible to remove a burned lining without breaking off the headers holding them in place

Firebrick should be of the first quality and the kind should be chosen after the probable furnace temperature is estimated. For oil or powdered-coal fired furnaces fireclay should not be used.

The height of the bridge wall was controlled by the theory that the radiant heat from it would ignite the green coal near the firedoors. The bridge wall recedes from the stoker dump plate at an angle of about 60 deg. for a distance of a foot, so that the radiant heat will not warp the lower grate bars if the fire gets thin.

The hand stoker was given an incline of 15 deg. so that the ashpit would not be so deep as to make the removal of the ash hard for the fireman. The boiler was set 74 in. from the floor, as it was figured that with Pennsylvania mine-run coal this would give good efficiency with natural draft at 100 to 125 per cent rating.

We found that the stoker angle of 15 deg. is too flat

for the best results. Coal does not move toward the rear of the grate as it should by operating the shaker bar. The angle should be at least 20 deg. and 25 deg. would be better. Ashes can be removed from the ashpit with a 20-deg. angle without much trouble; a greater angle would of course be more difficult. An observation door in the side of the furnace is necessary for the successful operation of a hand stoker.

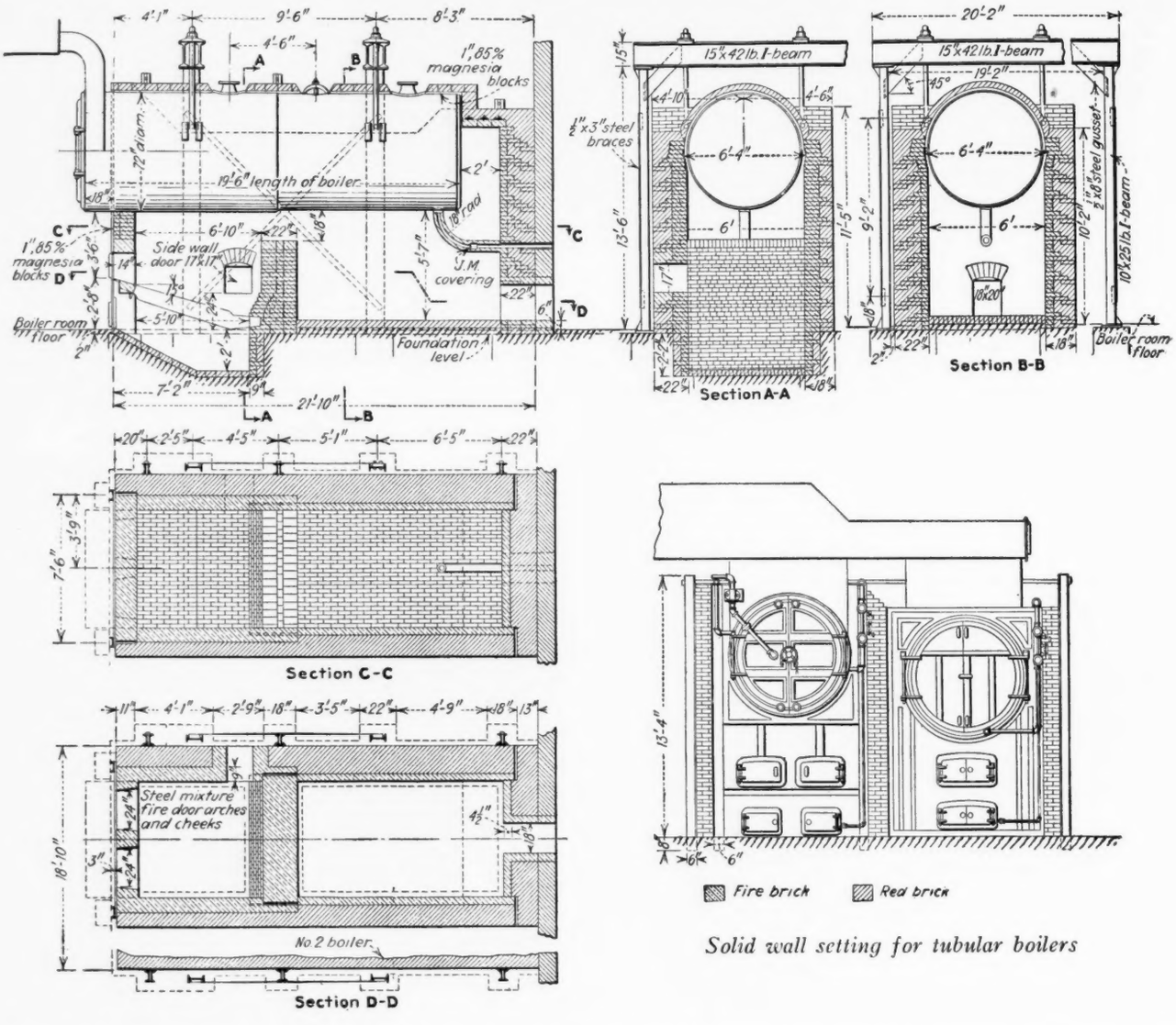
I should like to say for the benefit of engineers in shoe factories that refuse from the factory can be burned on a hand stoker without any trouble, in spite of the fact that considerable quantities of tacks and nails are mixed in with it.

I find that with a single uninsulated brick wall there is considerable heat lost through the wall and that there is practically no difference in the amount lost at light and full loads. This loss can be greatly reduced by using insulating brick on the outside of the wall and then covering the whole setting with one or more inches of magnesia. The magnesia will help to seal up any cracks.

We use molded pieces for the fire door arches and jambs, as they will stand the hardest wear and, if put in right, can be replaced more easily than brickwork. For the observation door in the side wall we used 9-in. arch brick, laid to break the joints.

From our experience I have concluded that the best kind of setting for a boiler is a single wall built with a 9-in. firebrick lining in the furnace and a 4½-in. firebrick lining in the rear of the bridge wall. Headers should be put in every four courses, overlapping each other through the wall as shown in the illustration, so as to support the lining from the outside. Firebrick, if laid up with fireclay, should be dry and laid as close together as possible. Do not let the masons tap them into place with a hammer; make them dip them in a thin fireclay, wash and rub, and shove them into place. Firebrick should be chosen with regard to furnace conditions. The red brick should be of good hard-burned grade 2¼ in. thick and wire cut. A wire-cut brick will cost a little more, but a mason at $16 a day will soon waste in labor more than their extra cost trying to lay the ordinary brick well and then not have as good a wall as the cut brick will make. A 2¼-in. red brick will lay up in even courses with firebrick with a ¼-in. bond, which is the best for boiler work. Good boiler brickwork should not measure over 23½ in. for nine courses.

The outside of the wall should be of the insulating type of brick. The whole setting should be inclosed in a steel casing with two inches of magnesia between the casing and the brickwork.



Solid wall setting for tubular boilers

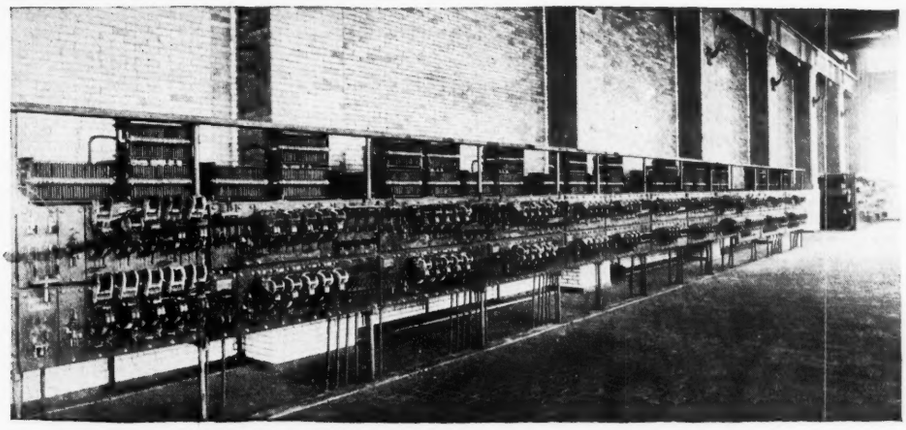


Fig. 1—Grouping of control panels in blooming-mill motor room

SELECTING CONTROLLERS
for Direct-Current Motors

By W. H. Costello
Engineer, The Cutler-Hammer Manufacturing Company

ONE method of starting direct-current motors is by connecting them directly to the line. This way is infrequently used except for small motors up to ¼ hp., but may be used for larger motors of special design. A second method of starting, and the one commonly used, is to reduce the voltage applied to the armature terminals by connecting a resistor in this circuit. The resistor is gradually reduced as the motor gains speed, until full voltage is applied to the machine.

A shunt motor has its field winding connected directly across the line, consequently its field strength is practically constant and there is little change in speed from no load to full load. The speed may be reduced below normal by placing a resistor in series with the armature circuit, but this method has the disadvantage of being wasteful of power and it has a speed varying with the load. It has the advantages of allowing speed control with any standard motor and of low first cost. The speed of a shunt motor can be increased above normal by weakening the field. This method of speed control is efficient because the power loss in the field rheostat is practically negligible. It has the further advantage that for a given field current the speed is practically constant for all loads. The speed of nearly every standard shunt motor can be increased 10 to 25 per cent in this way, but if the field is weakened too much, commutation troubles will result and the operation may be unstable. Motors designed especially for wide speed control by field regulation overcome this limitation. The best-known motor for wide speed range by field control is the interpole type.

The speed of a series motor varies with the load. It is used to a very limited extent for industrial applications. For this reason this type will not be given further consideration in this article.

The characteristics of the compound-wound motor are between those of the shunt and series types. If the series winding is light the motor will perform nearly the same as the shunt type, while if the series winding has a large number of turns the motor's characteristics will approach those of the series motor. The speed can be varied below normal by the use of a resistor in the armature circuit, and speed regulation above normal can be obtained by a rheostat in the shunt-field circuit.

The types of commercial starters used for compound-wound motors are practically the same as for shunt motors. Nearly all direct-current controllers are of the armature-resistor type, field-resistor type or a combination of the two. There are other methods of control which, are sufficiently different to warrant special mention. These are: (1) Multi-voltage control; (2) Ward-Leonard or variable-voltage system; (3) control by armature shunting. These have been used largely in high-speed elevator applications where wide ranges of speed control are required. One of the oldest and best-

Types of Direct-Current Motor Controllers

MANUAL	AUTOMATIC
Acceleration	*Acceleration*
Across-the-line	Across-the-line
Face-plate	Dashpot time-limit
Multiple-switch	Inductive time-limit
Drum	Mechanimal time-limit
	Counted-E.M.F.
	Current-limit lockout
	Current-limit series-relay

known types of starters on the market is the faceplate type. It is simple, effective and inexpensive. The lever is usually held in the "on" position by a magnet the coil of which is in series with the shunt field. This inherently gives low-voltage protection and also protects the motor against damage should the circuit of the shunt field open.

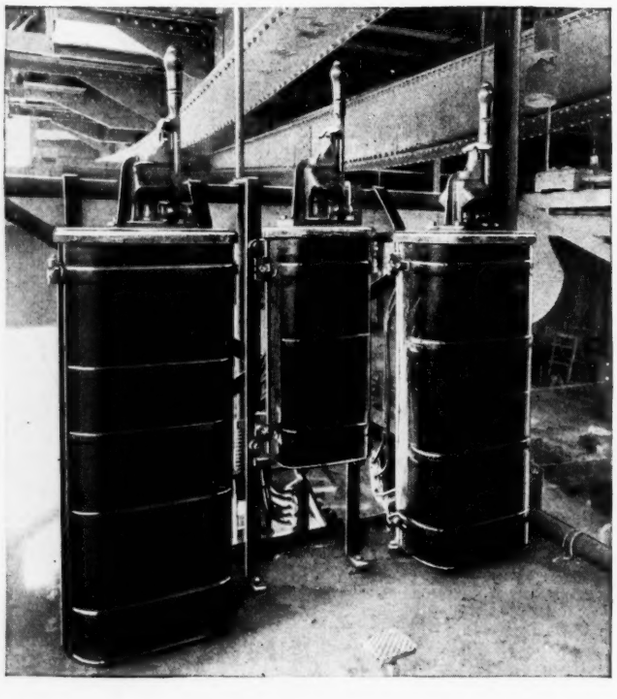
The standard direct-current faceplate starter is nonreversing. Overload protection is usually obtained by a separate fuse panel or a separate circuit-breaker panel. These panels, however, may be combined with the starter panel and mounted on the same frame or in the same inclosing case to make a more complete starter. Another feature frequently supplied in addition to the plain starting function is speed regulation by weakening the shunt field. This same form of controller is also used for armature-control speed regulation, by designing the contacts and resistor for continuous duty. The faceplate starter is used for motors up to 50 hp. at 230 volts.

Standard multiple-switch controllers are rated up to 200 hp. at 230 volts. These starters consist of a number of levers or switches of special construction, each of which must be closed by a separate motion. The closing of the first switch on the left connects the motor to the line in series with all the resistor. Closing of succeeding switches short-circuits the resistor step by step until the motor is running on full voltage. Multiple-switch starters are furnished in either the open or inclosed structure. This type of starter is generally used for large motors.

Just as the faceplate type starter is subject to certain limitations, to overcome which the multiple-switch type was developed, so the latter also has its limitations. A third type of manual controller, known as the drum type, is made to meet conditions where the faceplate and multiple-switch type would not work advantageously.

Some of the advantages of the drum-type construction over the faceplate and multiple-switch type are: More substantial construction; owing to its construction and method of operation heavy pressures can be maintained between the contact surfaces; blowout and arc barriers

Fig. 2—Three drum-type controllers in crane cab



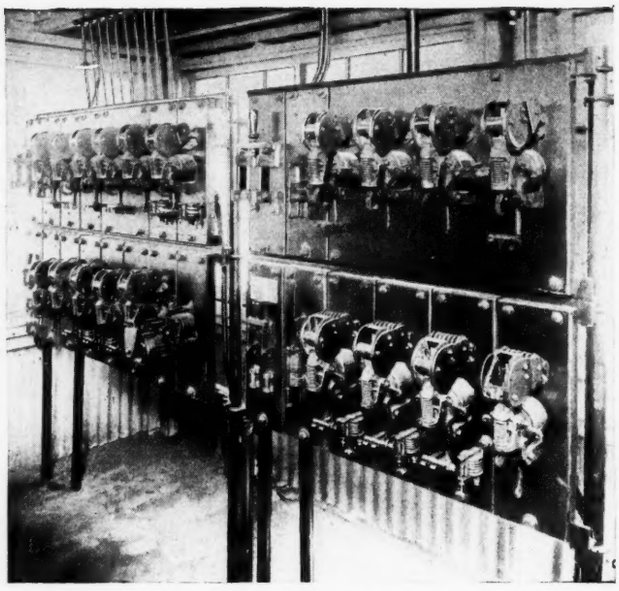


Fig. 3—Main-hoist and trolley control panels for a gantry crane

can readily be provided; it lends itself readily to complete inclosure; the more complicated circuits such as reversing are more easily handled; the space required by a drum controller is usually less than for a faceplate or multiple-switch controller of equal capacity to perform the same function; and it is operated with less effort than other types of controllers.

Low-voltage release and low-voltage protection are not inherent in a drum-type controller, but must be provided as an additional feature. This is usually accomplished by using a magnetic switch in conjunction with the drum controller. The coil of the switch is energized from an auxiliary contact in the drum, which may be so arranged as to give low-voltage release or low-voltage protection as desired.

The resistor for a drum controller is generally furnished in a separate box or frame. It is cheaper for the user to install the resistor and drum separately and to wire between them than to pay the manufacturer for the labor and material necessary to mount the resistor and drum as a unit.

A plain single-pole or double-pole switch may be used for across-the-line starting on direct-current motors, but this type of starting is limited to very small motors or to motors of special construction infrequently used.

A large percentage of automatic starters of the time-limit type have dashpot control. Both oil and air dashpots are in common use. There have been objections to the air dashpot because, if it is not oiled occasionally, its leather dries up and the effect is lost. Also, if it is installed in a dusty place, the valve is likely to clog and change the timing.

The success of the oil dashpot depends upon the kind of oil used, it being necessary to have an oil the viscosity of which does not vary too widely with changes in temperature. It was only during the last few years that an oil answering the requirements was available. Dashpot oil that works satisfactorily in temperatures as low as 20 deg. F. can now be obtained. Because of the reliability of present-day dashpot-type mechanisms, the time-limit starter has returned to favor where formerly a prejudice existed against it.

A familiar form of dashpot-type automatic starter con-

sists of a rocker arm carrying four or more drum fingers, the rocker arm being moved by a solenoid magnet against the action of an oil dashpot. Low-voltage release is inherent, and the provision of maintaining contacts allows for low-voltage protection by three-wire control.

The standard adjustment interposes $3\frac{1}{2}$ to 7 sec. between the instant the first finger makes contact and the instant the last one touches. A minimum of two seconds and a maximum of 30 can be obtained. Either open or inclosed construction can be supplied. For overload protection, fuse protection or circuit breakers can be supplied with starters of standard design.

Time-limit starters of the pilot-motor type are considerably more expensive than the dashpot-type for small sizes, but it is possible to get long timing. This construction is used widely for laundry washing-machine controllers where the timing function is of utmost importance.

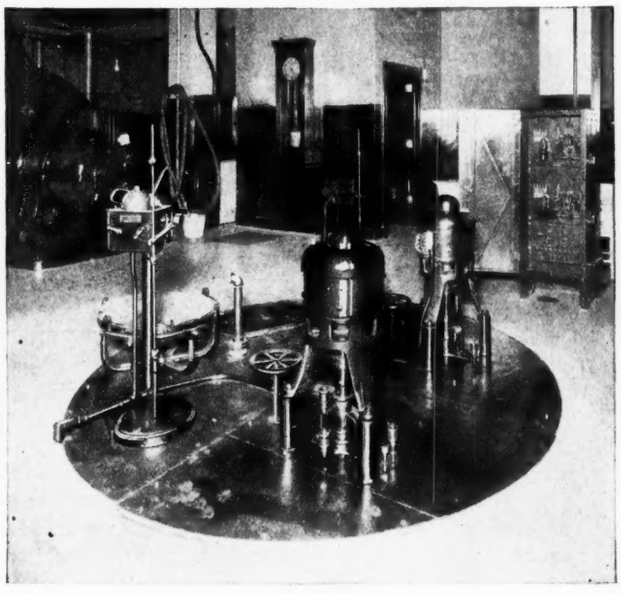
Where rapid acceleration of motor must be obtained, advantage has been taken of the inherent time lag in magnetic contactors to obtain the desired results. The accelerating current, however, is nearly six times the running current, which is obviously too high except for special service. Screw-down service in steel mills is one application for this type of starting.

One of the recent developments in direct-current controllers is the inductive time-limit type, commonly known as the I.T.L. This controller is considerably more expensive than the dashpot time-limit type, but it has the advantage of simplicity and sturdy construction. It eliminates the use of relays, dashpots and electrical interlocks and finds its greatest application in steel mills, where simplicity and reliability are at a premium because of the severity of the service.

Counter-electromotive-force type controllers are those in which the rate of acceleration of the motor depends on the counter voltage of the motor's armature. The accelerating contactor coils are connected directly across the armature circuit and calibrated so that they will close at the proper voltage.

When the motor load is fairly constant the counter-electromotive-force type of starter is satisfactory, but where the starting load is widely variable the action is not so dependable and time-limit starters may be preferable. In addition, the operation is affected by the temperature of the contactor coils. When the controller is cold the contactors will close on a lower voltage than when hot, because of the lower resistance of the contactor coils.

Fig. 4—Sump-pump motors operated by full-automatic control



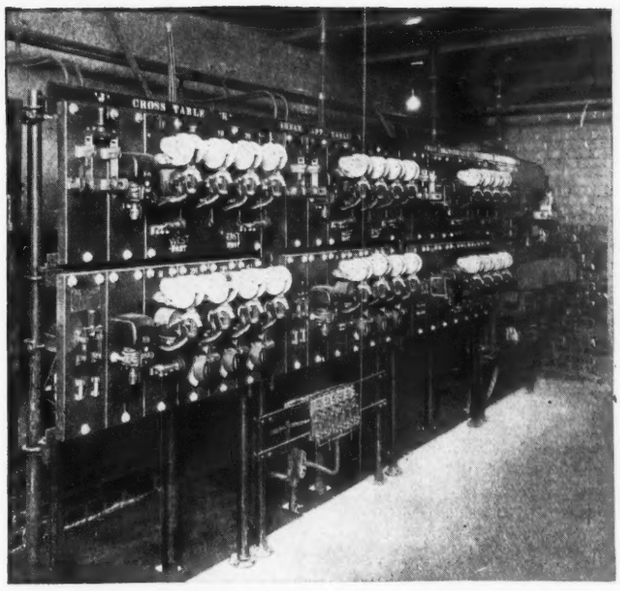


Fig. 5—Full automatic, master operated, induction time-limit acceleration controllers on table and chain transfer in steel mill

The principal advantage of this type of starter is its simplicity. Standard starters of this type are rated up to 10 hp. at 230 volts. For higher powers the characteristics of the time-limit starter are usually more desirable.

Current-limit acceleration can be obtained by (1) self-contained contactors of the series-lockout type and (2) series relays and shunt contactors.

Series-lockout contactor controllers have the desirable feature of simplicity and ease of adjustment. Lockout contactors have two series coils, one for holding the contactor open and the other for closing. The number of lockout accelerating contactors depends upon the load, size of motor and the allowable current peaks. The contactor coils are connected in series with the armature circuits.

After the first accelerating contactor of the lockout controller has closed, the current peak that results will keep the next accelerating contactor from closing until the motor has accelerated to a point where the current drops to the predetermined value, which allows the contactor to close. This action is repeated until the motor is across the line.

Series-relay controllers are more complicated than the lockout type, because shunt contactors are used plus a series relay, for each point of acceleration. Series-relay acceleration is used on direct-current motors, where speed regulation from a master controller is desired, as on cranes, hoists and similar equipment. The use of electrical interlocks for series-relay control together with shunt coils makes the upkeep somewhat higher than for lockout controllers.

Another application of the current-limit principle is the use of vibrating field relays on direct-current auto-

matic starters where speeds above normal are obtained by inserting resistance in the shunt-field circuits.

This method is widely used on controllers for machine-tool motors. Ordinarily, if the shunt field of a motor is suddenly weakened by inserting too much resistance, there will be a high current surge due to the increased counter voltage of the armature. However, when a vibrating field relay is used, the relay will close and short-circuit out the field resistance, thereby maintaining the armature current and the acceleration within the required limits.

Likewise, if the motor is running at high speed and the field is suddenly strengthened by cutting out the field resistance, there will tend to be a large increase in the armature voltage. Where a shunt vibrating field relay is used, the relay will function to decrease the field current gradually to keep the voltage and deceleration within the required limits.

Dynamic braking and slow-down is obtained by shunting a resistance in parallel with the armature while the field is being maintained. This is a desirable feature for crane, hoist and machine-tool service. The fact that direct current affords easy dynamic braking is responsible for its being retained for certain classes of service where alternating current would otherwise be more acceptable.

Ten Pointers on Making Elevator Inspections

By H. C. Russell

METHODS of making elevator inspections will vary considerably with the men doing the work. My system for making routine inspections is about as follows:

1. Disconnect the signals and instruct the operator to move the car only under my direction. Visit the machine room and observe the operation of the machine, brake, terminal slow-down switches and control board, for a few trips, making such minor adjustments as are necessary and that can be done with tools and material at hand, and that can be made in a short time.

2. Inspect and test all electrical safety devices such as hoistway limit switches, car emergency switch, gate- and door-interlocking switches (if any), slack-cable switch, etc. The governor cutout switch may be left until inspection of the governor is reached in the regular order that the inspections are made.

3. Inspect the car switch, generally by watching its operation with the cover removed and looking for worn or burned parts.

4. Ride on top of the car and examine all cables in one or more trips by having the car moved two or three feet at a time. Parts of the cables that cannot be reached in this way are inspected from other locations. During these trips examine all cable fastenings on the car, counterweights, governor stop balls, the securing of the car and counterweight guides, play of the car and counterweights in guides, lining of guide shoes, lubrication of guide rails and for loose bolts. See that the governor-cable releasing carrier is sufficiently tight to retain the stop ball but very little more. Take a look into the junction box in which the traveling electric cables for the car are connected to the stationary wiring.

5. Examine the governor for general condition, loose pins, worn bushings, cleanliness, etc. Raise the weights and see that the various gripping devices come into action as intended. See that the governor switch, which opens the potential switch when the governor goes into action, opens a little before the cable is stopped. See that the gripping dogs on the governor will actually grip the cable. Some governors require not only a cable of a certain diameter, but also a certain stranding to accomplish this, but it should not be difficult to see at a glance if the gripping action is sufficient. See that the segmental gears (if any) are free from hardened grease and dirt.

6. Examine the overhead work (if basement machine is used) for worn bearings, worn bushings, sheaves out of line, loose bolts and lubrication. Observe the operation while several trips are made with the car to detect an unusual performance.

7. Examine the safety under the car. With a shim gage see that the clearance between gripping jaws and guide rails is correct, or at least uniform. Unwind the tail rope or whatever operation may be necessary to set the gripping jaws, until the jaws have gripped tight, as ascertained by shaking the car by hand and trying a thin shim gage under the jaws. No gage should enter if the jaws are tight. Most graduated-action governors are supposed to stop the car in about ten feet. In such a case the amount of tail rope unwound should be about seven feet.

If a drum-type safety is used not less than one-half the tail rope should remain on the drum after the jaws are set in this manner by hand. The tail rope can be unwound by hand or the continuous rope pulled by having the operator descend slowly after the gripping dogs are set on the governor or whatever method may be used to stop the travel of the governor cable. This method will set the jaws much tighter than can be done by hand, but obviously not so tight as if the car were falling or being overspeeded.

With traction machines care must be used to see that the traction sheave is not raced after the gripping jaws have set. With drum machines, see that the drum counterweights are not pulled into the car counterweights, as would happen if the machine continued to run after the car stopped. The slack-cable safety on a drum machine is supposed to stop the machine before the lower counterweights are pulled into the upper or car counterweights.

8. Inspect the traveling cables on the car switch, car emergency switch, lights, annunciator circuits, for wear and injury. Often the cause of a worn spot is found to be something in the hoistway which strikes the cable on each trip and can be removed by moving the obstacle or slightly changing the hanging of the cable from the car or hoistway.

9. Inspect the bumpers in the pit, under the car and counterweight, the weighted sheave on the governor rope and compensating cables.

10. Inspect the car gates, hoistway doors, tracks, door-operating devices, etc., for proper and safe operation. See that no door can be opened from the landing side except with a key or special tool. Inspect the interior of the car and condition of the floor covering. The latter is more of a safety measure than would appear on first consideration. Passengers sometimes stumble on worn floor coverings.

The time consumed by such an inspection as outlined is about two hours in a three- or four-story building unless something unusual is encountered.

Portable Fan Supplies Draft

After Stack Blows Over

By A. Downing
Supervising Engineer, Allied Packers, Inc.

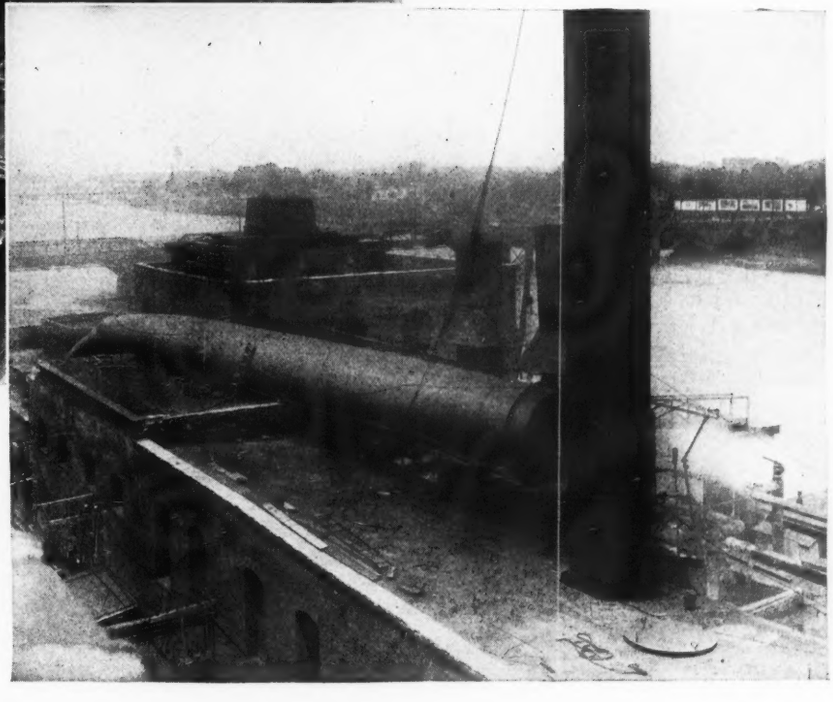
TOPEKA, Kansas, was recently visited by a severe windstorm at midnight, which blew down the chimney at the plant of the Chas. Wolff Packing Co. The force of the wind coming from the east pulled one of the stack anchors out of the ground, allowing the stack to fall in a westerly direction. In falling, the end of the stack went through the roof of an adjacent building, but only slight damage was done. The main steam line in the plant was broken off, and a 4-in. ammonia pipe was demolished, permitting the escape of a considerable quantity of ammonia.

The plant generates its own electric power and operates its refrigeration machinery with steam, so it will be seen that with large stocks of perishable meats on hand the company was faced with the possibility of serious losses unless service could be promptly restored.

Arriving on the scene shortly after the accident, the chief engineer organized his staff and shut off the flow of ammonia. By the light of lanterns, torches, etc., the steam main was repaired and fires again started in the boilers.

Fortunately, the plant had available a portable fan mounted on a truck. It was, however, too small to handle all the gas from the boilers. By arranging the fan so that the gas it was able to handle discharged through a nozzle at high velocity parallel to the sides of the breeching, enough draft was created to permit boiler operation at a rate sufficient to maintain steam pressure. Electric service was restored at 4:30 a.m. Installed in this manner, the fan operated on the injector principle to literally "blow the gas out of the breeching." Not long afterward the ammonia lines were repaired and the refrigerating system was again placed in operation.

Plant manufacturing operations were suspended the next day, so that the engineering department could "catch up" on temperatures, which had risen somewhat in the cold-storage rooms during the shutdown period, but all operations were restored to full capacity during the following day. In order to reconstruct the chimney, a temporary stack was built of light material and the breeching connected to it in such a way that the flue gases could be discharged to the atmosphere without interfering with the men working on the construction of a new stack.



Temporary stack beside one destroyed by storm in Kansas plant

The Inexperienced Engineer

Starts a Refrigerating Plant

By C. L. Marks

WHEN an engineer is placed in full charge of a refrigerating plant for the first time, particularly if his training has been limited, the first problem that presents itself is, "What must I do to keep out of trouble?" Once this has been satisfactorily solved, the next problem is to get satisfactory results, both as to capacity and efficient operation.

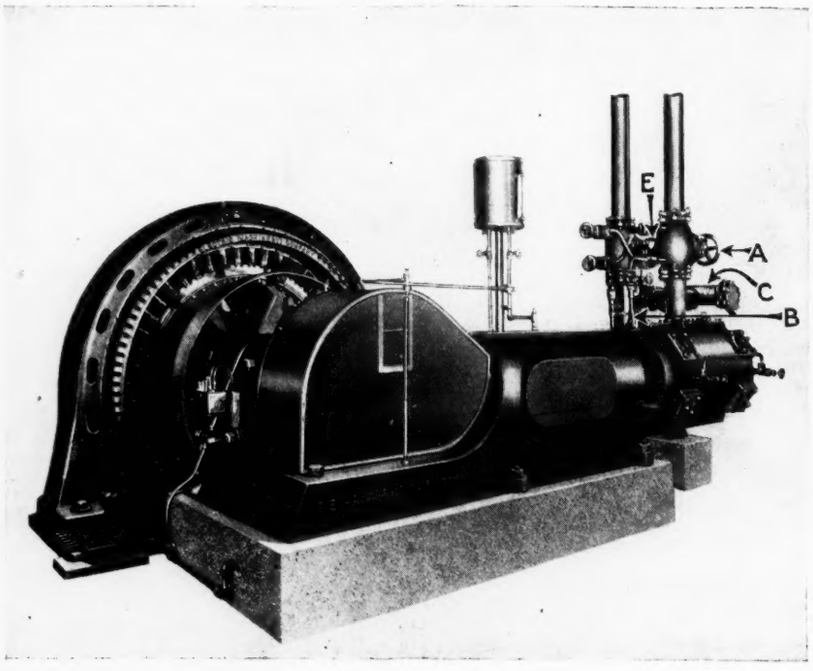
If the plant is shut down, the first problem is to get started. We will assume that the man knows what to do to start the engine or motor driving the compressor. There are five major things that should be attended to before any attempt to start the machine is made by a beginner. He should make sure that all valves in the discharge line from the compressor to the condenser and all the gas and liquid valves on each individual stand of the condenser are full open. If most of them are open the few that are not have probably been shut off on account of leaks, and they should not be touched. Leave them as they are, for the plant has probably been operated in this condition before, and after the plant has been started and is working properly, an investigation can be made as to why they were shut off. The pump-out valves on the condenser, which will be found to be the smallest valves and connected to a small pump-out line that runs back to the compressor, should be shut off tight on each stand. Next start the water circulating through or over the condenser. This may require the starting of a separate circulating water pump or it may be taken from the house-service system. In either case, particularly in the summer, start a liberal flow of circulating water, although in the case of atmospheric condensers do not force any more water over the stands than will flow down over the pipes without splashing. This being done, examine the piston-rod stuffing box to see if it is set up tight. Generally, it is drawn up tight after the compressor has been shut down, as the rod generally cools off and the stuffing box begins to leak as soon as the machine is shut down if a fibrous packing is used. Back it off about half a turn if it is equipped with one large gland nut, or about a turn if it is equipped with several studs and nuts. This gives the rod room to expand when the machine is started.

See that the suction stop valve *A* on the machine is shut. A slug of liquid may be lying in the suction line, close to the machine, and if the suction is open, even a turn or more, this liquid will be drawn into the machine and cause damage.

The expansion valves at the evaporating coils should be shut off tight or, better still, see that the liquid line to the expansion valves is shut off at the liquid receiver. Sometimes a careless engineer will leave both the expansion valves and the liquid line open, with the result that a large amount of liquid passes into the expansion coils and floods the suction line. If the machine is started and the suction valve opened wide, this liquid will be swept into the machine. If it does not wreck a cylinder, it will strain the reciprocating parts and sometimes throw the whole machine out of line. Care should be taken to prevent every possible chance of liquid getting into the compressors.

Some engineers, in starting a Corliss engine driven ammonia compressor, make a practice of rocking the engine for some time before hooking up and starting. This should not be attempted until the engineer is sure that the compressor discharge is open to the condenser. If the pump-out connection on the machine is open or if the suction valve happens to be slightly open, enough gas is drawn into the compressor by each move of the compressor in rocking the engine, to cause the relief valve on the compressor to blow in case the discharge line is not open. These are the important things that

The vital valves on the compressor



should be checked before the machine is started.

Another matter that should be checked, although it will not result in serious consequences if it is overlooked, is to see that the bypass, or pump-out, valves on the compressor are closed. If these are open, the machine will start and run without serious consequences, but will do little, if any, work and will generally heat up. This, however, will be promptly indicated by the failure of the discharge pressure to rise and the suction pressure to come down. The gas will be heard whistling through the bypass valves and all that is necessary to get things to normal is to shut these tight.

Most compressors are equipped with a gas-relief line leading from the center of the stuffing box to the suction side of the machine, shown at *B* in the illustration. The valve in this gas relief line should be opened; if it is shut, as is mostly always done when the machine is shut down, the gas will back up from the suction line in a great many cases and continually leak out through the stuffing box.

Ready to Start

We should now be ready to start. If the machine is motor-driven, there is generally provided a large bypass line *C* with a valve, connecting the discharge header of the compressor with the suction side of the system or the suction side of the machine. Make sure that this bypass valve is open. Once the motor-driven machine is up to speed, shut the large bypass valve off promptly.

Immediately begin to open the suction stop valve *A* on the machine a fraction of a turn at a time, meanwhile touching the discharge header regularly. If the discharge header warms up continually, it is safe to keep on opening up the suction valve. It is not advisable for a new man starting a strange plant to leave this valve wide open at the start, because, if he should want to shut it off in a hurry, it is better to have it partly closed until he is satisfied that everything is all right.

If the discharge header begins to get cold, and the valves begin to work very quietly, shut off the suction valve until the discharge header again warms up; this lack of heat is an indication that there is liquid present in the suction gas, which must be worked through before any attempt is made to open the suction valve wide. When the discharge header remains warm, with the suction valve two or three turns open, it is safe to assume that most of the liquid has passed through and attention can be turned to other things.

Once it is safe to leave the suction stop valve, take a look at the stuffing box. The gland nut or nuts should be backed off a little at a time until they feel somewhat free but still hold the packing tight. If the packing is loosened too much it will be ruined, although it will often start to blow before this point is reached. If the stuffing box and packing are in decent condition, the packing should never get hot enough to smoke. Be sure, however, that it has plenty of oil and that the gas relief line is open.

The Machine Is Running

Once the machine is up to full speed, the suction valve pretty well open, the discharge pressure not excessively high and the stuffing box going along without showing signs of smoking, open up the valve in the liquid line at the liquid receiver, if this has been shut off, and any other valves that may be found in the liquid line between the receiver and the expansion valves.

Now comes one of the most difficult problems for the beginner. On long expansion coils in warm rooms the expansion valves can be opened as much as half a turn, sometimes even three-quarters of a turn. On short coils in very cold rooms the valves can be opened only just enough to be off the seats, and sometimes even that seems to be too much. On large brine coolers the expansion valves can often be opened a full turn.

Handling the Expansion Cocks

As a preliminary settling, however, if the coils are from 1,500 to 2,000 ft. long, and in a room where the temperature is around 30 to 35 deg. F., the expansion valve should be opened about half a turn. In the lower-temperature rooms give the long coils about one-quarter turn and the short ones just enough to hear the liquid sizzling through. This will do for a preliminary setting. With half a dozen valves on the system the problem becomes more difficult, particularly if a number of different temperatures are maintained and the coils are of different lengths.

With the preliminary adjustment made, keep a close watch on the machine, and if there is no thermometer on the discharge side, feel the discharge pipe regularly by touching it with the hand. If it feels cool to the hand, the expansion valve on some coil is opened too much, so that liquid is coming over to the machine. If the discharge heats up to a point where the hand can be held on it for only an instant, it is too hot and the expansion valves must be opened more.

If the machine gets cold, it is safest to close up all the valves a little until it begins to warm. If it cools off very quickly, it is best to shut off the liquid line at the receiver and pump down for a few minutes until the machine begins to warm up again, after which the liquid valve is opened again. After a few experiments of this kind a setting is generally found where the temperature of the machine will remain fairly warm and uniform, and for the beginner to be on the safe side it is better to run the machine cool at the start, on account of stuffing-box troubles.

Once a point has been reached where the machine has settled down to fairly warm and uniform condition, each expansion valve should be experimented with in turn, without touching the others, until a point is reached where no valve can be opened farther without making the machine cool off. When this point has been reached, each valve will be feeding all the liquid that its coil or cooler will evaporate and the machine will be working to the best advantage.

The Condenser Pressure

As long as the condenser pressure remains below 200 lb., there is nothing to worry about, although it is always better to start up with as low pressure as possible, which means that the maximum amount of water should be circulated over or through the condenser until the machine is settled down to normal. It then becomes a question of whether to economize on water or to be liberal in the use of water and save in power. The less water used, the higher will be both the condensing pressure and the power required, and the capacity of the machine will be slightly reduced. Where a cooling tower is used, it should be run to full capacity and the condensing pressure allowed to take care of itself. Where the water is supplied from a well or city mains, a different problem is met. Well water is sometimes limited and city water is expensive, consequently it is best in most cases to run with a condensing pressure ranging

from 165 to 185 lb. gage under these conditions. If the engineer holds the discharge pressure somewhere between these limits, he will generally not be far wrong.

Shutting down the plant is a comparatively simple matter, as compared to starting. First shut off the liquid line at the liquid receiver; this shuts off the liquid to the expansion valves and the low side of the system, and the liquid line back to the liquid receiver will be pumped down in a short time. Let the machine run until the suction pressure is pumped down to zero gage. Leave the expansion valves as they are; they will need no attention until the next start is made. As soon as the suction pressure reaches the proper value, shut down the machine and close the suction stop valve. If the machine is to be shut down for any length of time, close the discharge stop valve *D* and open the bypass valve *C* from the discharge header to the suction side of the system. This brings the pressure on the stuffing box down to the suction pressure, which greatly reduces the leaks.

Shutting Down the Machine

If the machine is being shut down for a day or more, it is advisable to close the valve in the discharge line at the condenser, open the bypass valve around the check valve in the discharge line, and open the bypass valve on the compressor which connects the discharge line with the suction side of the machine. This allows all the gas in the discharge line to pass over to the low-pressure side of the system, reducing the pressure to suction pressure and greatly reducing the liability of leaks.

A lot more can be said on this subject, but these brief suggestions will give the untrained engineer some idea of how to keep out of the most serious troubles. If a man will keep close watch on the stuffing box and the condensing pressure and keep liquid out of the suction side of the machine, he will generally get along until experience teaches him what to do.

Mystery in an Ice Plant

By M. F. Knoy

IN DAYS past many of us have heard strange tales of the doings of ammonia in and about the ice plant. Many housewives will testify that too much ammonia in the ice will cause it to be white or red or vile tasting. Others have heard of a faint whiff of this mysterious substance being sufficient to kill a man instantly. Whole gangs of negro workmen have been known to leave a job *en masse* because some of them smelled, or thought they smelled, ammonia.

To those who are familiar with the properties of ammonia and the manner of using it to produce refrigeration, such stories are ridiculous. But many plant operators can also tell you of strange happenings in ammonia systems, some of whose causes have yet to be determined. Now the refrigerating engineer is prone to laugh at these stories as well. He knows very well that ammonia is a law-abiding substance that plays its game of evaporation, liquefaction, expansion and compression according to fixed rules; and that it never acts out of malice or caprice. These men make it a point to familiarize themselves with these rules of behavior and thus put themselves in a position to predict accurately what the substance will do under any given set of conditions.

But again, the best engineers will tell you that once in a while they encounter a problem that taxes their powers of analysis and causes them to say things about ammonia that they would not say in their saner moments. I recall an incident of this kind related to me by a veteran ice-plant erector. He had installed a great many ice and refrigerating plants and had achieved quite a reputation as a trouble shooter as well. Now this man knew refrigeration, and he knew how to handle ammonia backward, forward and crosswise. Hence, he was the more astonished when he came across a problem that absolutely stumped him for the time.

He had just installed an ice plant of standard design, and everything was ready for the trial run. But when it was put into operation, a strange thing happened. An ample charge of ammonia was in the system, but instead of the receiver having a constant liquid level, it would fill up and run completely empty by turns. This occurred at almost constant intervals day and night regardless of any adjustments that were made. No one present had ever heard of such an occurrence, and it was the more surprising to the erector in that he had made several previous installations identical with this one so far as equipment and mode of connection were concerned.

When he had tired himself out walking in circles, he boarded the train for a near-by city. After he had relaxed a little, he started in to do some heavy thinking, and he did lots of it. The next day he started back to the job, well rested and inwardly jubilant. He was sure he would corner the jinx this time, and he did.

For convenience, the receiver had been partly sunk in a pit. On examining this pit closely, he found one of the walls to be hot. He was much surprised to learn from the engineer that an underground, uninsulated steam-pipe passed near this point. The erector was the only one who had not known about the steam line all the time, but the others could not see what a hidden steam line would have to do with a perverse ammonia system.

It was explained to them that when the receiver filled up with liquid its rapid evaporation, due to the heat, sent such a volume of gas back up to the condenser that all liquid condensing there was temporarily trapped. Then when the receiver had run dry, the current of gas would cease and the trapped ammonia liquid would come down from the condenser in a deluge, and the process would start all over again.

After the steam line was replaced by an overhead insulated line, the plant operated normally.

Which all goes to show that it is well for the refrigerating engineer to know his ammonia, and that an observing eye and a good imagination may also assist him in chasing the jinx from the ice plant.

Coming Next Week

A small plant embodying all the refinements essential to efficient performance and complete records. Pulverized coal is burned without ash recovery in the very heart of a business district. Read the description next week of the new plant of the Essex County Hall of Records, Newark, New Jersey.

Change in Duct Design Saves 400,000 Kw.-Hr. a Year

By E. D. Edwards
Chief Engineer, East Peoria Station

By applying modern duct design methods to the exit gas flues of the boiler the chief engineer of the East Peoria station increased the plant capacity by two per cent, secured a saving of auxiliary energy and improved the operation of the coal drying equipment. The changes that made these results possible are described in this article.

As originally designed, the double-width, double-inlet steel-plate induced-draft fans installed in the East Peoria station of the Illinois Electric Power Company, were driven by 125-hp. adjustable-speed motors capable of a maximum speed of 425 r.p.m. When burning Illinois coal with 27 per cent excess air, it was found that the operation of the boilers, which are fired by pulverized coal, was limited by the induced-draft fan system to 350 per cent of rating. At this rating the boilers did not deliver sufficient steam for plant needs. In order to increase the steam generation, the fan motors were increased to 200 hp. and the maximum speed to 500 r.p.m., this speed being as high as the fan design would justify. Under these conditions the possible boiler rating rose to 385 per cent. While this improvement was of some help, still it was not enough to meet the steam demands, 400 per cent being required. The limit of their capacity had, however, apparently been reached.

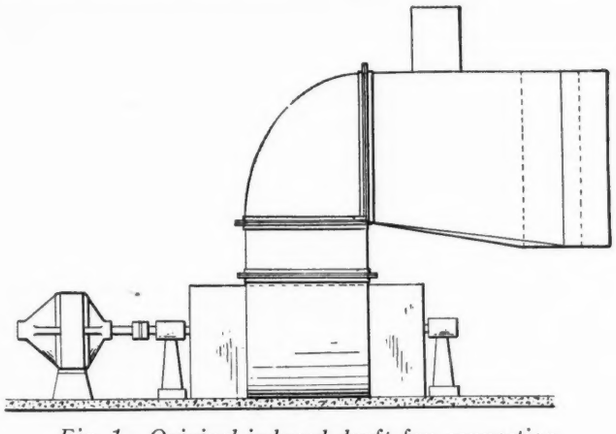


Fig. 1—Original induced-draft fan connection

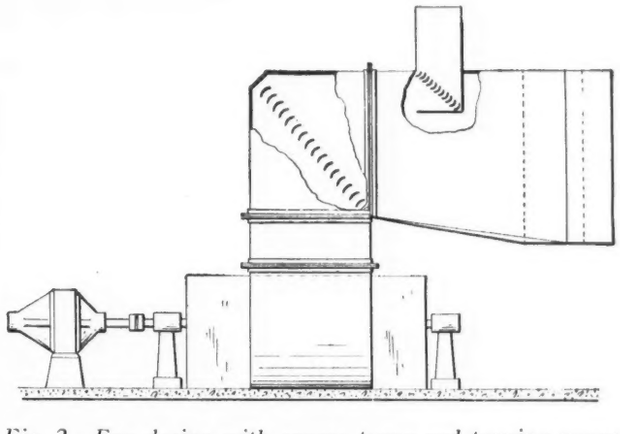


Fig. 2—Fan design with square turns and turning vanes

An editorial in the July 12, 1927, issue of *Power* directed our attention to some new ideas in duct designs given in an article by Loring Wirt, and based on research work of the General Electric Company. A copy of the article was obtained in the hope that it might point to a solution of our draft-loss problem, as it had long been thought that the friction losses in the flue-gas passages were excessive. In studying this paper we found that apparently many of our ideas of proper flue-duct design needed complete revising. In fact, some of the conclusions given in the article required such a complete reversal of what we had thought to be good practice that some skepticism was felt.

The paper deals entirely with results of tests made to determine the loss of pressure in right-angle turns of various shapes and proportions.

These tests indicated that the conventional elbow will have its resistance to gas flow reduced 10 per cent by replacing the rounded outer corner with a square corner, the loss of pressure in the case of a square duct being given in the one case as 1.54 times the velocity head and in the other case as 1.36 times the velocity head.

The aspect ratio of the elbow also influences to a large extent the pressure loss. Aspect ratio as applied to elbows is the length of the element of a cylinder forming the curved surface of the turn divided by the difference of the radii of the turn. To put the definition in a homely way, imagine the duct to be represented by a 2x8-in. plank and that the elbow is formed by bending this plank through 90 deg. If the plank is bent the easy way, the flow through the elbow is easy and the aspect ratio is 4. On the other hand, if the plank is bent the difficult way, the flow is difficult and the ratio is 0.25. The pressure loss through the first elbow would be about one-third that through the latter.

The most outstanding decrease in pressure loss was secured by fitting a number of short curved guide vanes

along the diagonal of a square right-angle turn. With this type of turn the loss in a square duct dropped to 0.22 times the velocity head.

After reading Mr. Wirt's article, it was decided to make a change of the discharge elbow on one fan. Figs. 1 and 2 show the arrangement before and after the change. The turning vanes were made of No. 10 steel and bent to 90 deg. on a 12-in. circle. After placing the boiler back in service, we were surprised indeed to find the maximum boiler rating was now in the neighborhood of 415 per cent, and in addition the power consumption had remained the same as for the corresponding fan speed

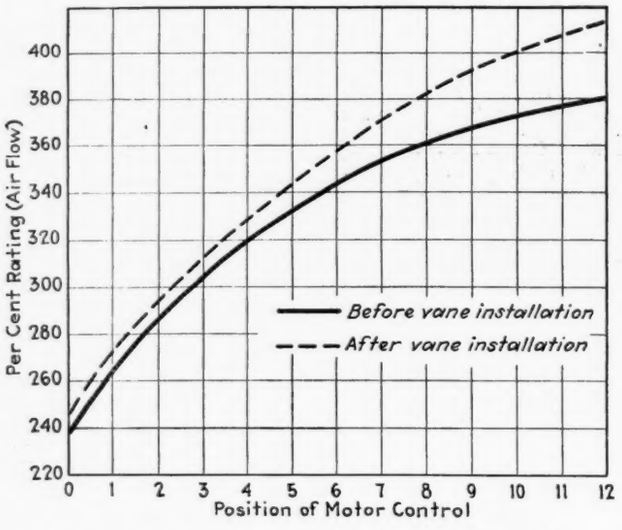


Fig. 3—Air flow before and after vane installation

previous to the change. In our case it may be that the excellent results were in part caused by the elbow being followed by an evasé section which, owing to the previous disturbed condition of the gas flow, quite possibly did not function as desired, but after the gas flow was smoothed out and evenly directed, did function as planned.

After changing the elbows it was found that where formerly there was a pressure at the inlet to the duct taking gas to the waste gas driers, there now was a suction. To increase the quantity of flue gas to the driers, another set of vanes was installed, as shown in Fig. 2, to act as a scoop and direct the gases from the induced-draft fan into these hot gas ducts. The gas temperature at the driers increased to such an extent that much better coal drying was had, and the power required per ton of coal milled dropped.

In summing up the gains due directly or indirectly to this change, the following figures are given as a conservative estimate, assuming the same total generation for 1928 as in 1927.

1. An increase of 2,000 kw. in the capacity of this 40,000-kw. station.

2. A decrease in fan power that during the year 1928 will amount to 273,000 kilowatt-hours.

3. A decrease in mill power from better drying, amounting to 135,000 kilowatt-hours.

This saving of 408,000 kw.-hr. in auxiliary power is equivalent to a saving in coal of 347 tons a year. It can be seen that it does not pay to overlook all chances of gain, especially when a test installation can be economically made, and that it pays to follow closely modern design tendencies.

Chemical Manufacturer and Power Plant Establish Co-operation

CO-OPERATION through the combining of the requirements of heat-using industries, such as central stations and chemical plants, is often advocated, but little progress is made toward its realization. It is worthy of note, therefore, that such a combination has recently been successfully made at Sand Springs, near Tulsa, Okla.

The Martin Process Company is engaged, at that location, in recovering chemicals from salt water found in oil wells by the use of its patented processes. This former pest of the oil field is now the source of many valuable products, in addition to large quantities of sodium chloride, or common salt. Among these are calcium chloride, bromine and bromine compounds, iodine and iodine compounds, magnesium sulphate and other magnesium compounds. Still other products can be produced by special processes in addition to the process used to obtain those mentioned. The salt obtained is claimed to be of high purity, making it suitable for use in revivifying zeolite water softeners.

The process at Sand Springs is a simple one and can be readily hooked up with the operation of a power plant. The brine is first mixed with lime and then run to a settling pond, where a sludge containing the magnesium hydroxide and the impurities settles out. The remaining liquor is pumped through spray nozzles in a spray pond 60x260 ft. in size. The pond is equipped with a trough in the bottom into which the salts settle as they crystallize out. The clear brine is drawn from this pond and circulated, as cooling water, through the condensers of the power-plant turbines, where it picks up heat. This heated brine is passed through the spray nozzles, where the evaporation concentrates the dissolved salts to the point of saturation and crystallization of the sodium chloride. These crystals drop to the bottom of the V-trough.

After the common salt has been removed, the resulting bittern is further processed for the recovery of its calcium, bromine and iodine salts.

The operations carried out by the Martin Process Company required close relations with the public utility company at Sand Springs. The two concerns have become dependent upon each other. It is, therefore, but natural that they have become affiliated. In addition to the interest that this tie-up holds for power engineers, the Martin Process Company, following a period of further experimentation and development, proposes to build several new plants, so that power companies in other districts will have similar opportunities to co-operate.

Eighty-Five Per Cent Magnesia Cement

The October, 1928, issue of *Asbestos* gives the following tips on the application of 85 per cent magnesia cement: "Magnesia cement is nothing but 85 per cent magnesia in powdered form. This is mixed with water to an easily workable consistency and applied with a trowel. When it hardens it is exactly the same material as the blocks or pipe covering. The cement shrinks on drying, so it should be applied in thin layers (about $\frac{1}{4}$ in.). Allow each layer to dry before applying the next. The shrinkage cracks do not harm if filled by the next layer. Wet cement will not stick well to hot metal. Wherever it is necessary to apply the cement directly to metal, it is well to start by dabbing on small amounts.

DIESELS *Solve the Power Problem of Ipswich, Mass.*

By
G. Grow

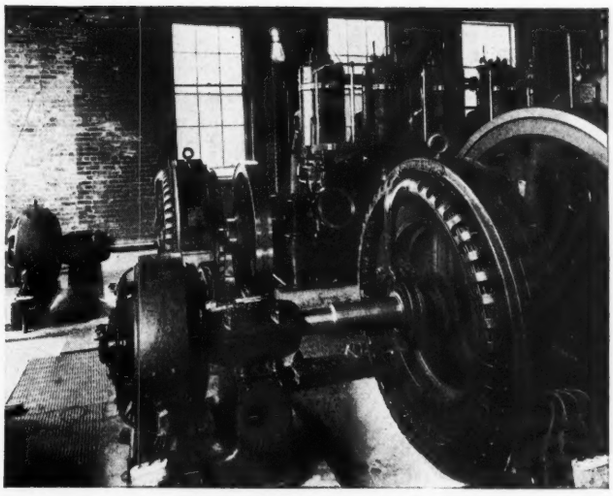


Fig. 1—The two Diesels installed at Ipswich

DIESEL engines frequently replace steam equipment in municipal plants, although in most cases it is quite usual to find the steam equipment in a run-down and inefficient condition. The municipal plant at Ipswich, Massachusetts, where Diesels were installed last year, was somewhat of an exception, since the entire problem involved in the extension of the light and water plant, consisted in a determination of whether it would be more economical to add another steam unit or whether it would be a better plan to install Diesel engines.

The equipment in the station previous to the installation of the Diesel units consisted of a 300-hp. compound Corliss engine direct connected to a 300-kva. alternator and two 120-hp. single-cylinder slide-valve engines direct connected to Stanley inductor alternators.

The Problem to Be Solved

Although the plant was operated fairly economically, the capacity was insufficient to meet the peak load, and so it was necessary to purchase three-phase current from Newburyport, Mass., to be changed over to two-phase through a Scott connection of transformers, since all the electric equipment in the plant was of the two-phase type in general use some years ago.

A study of the situation showed four possible solutions:

Install new steam equipment with three-phase alternators to replace the small Stanley inductor units and rewind the alternator for three-phase.

Purchase all current from Newburyport and abolish the steam plant.

Replace the Stanley inductor units with Diesel generator sets and either rewind the Corliss-driven generator or keep a Newburyport connection for auxiliary to the Diesel plant.

Install three Diesel units, two of which would be sufficient to carry the peak load.

A number of reasons, including high cost, eliminated purchased power and the final study was confined to the use of steam or Diesel equipment.

On investigating the problem it was found that the economy curves of a modern Corliss generating set and a turbine-generator set crossed at 500 kw. capacity. Below this rating the economy of a Corliss engine was better than that of a turbine. For this reason the study was confined to the possible addition of a 500-kw. Corliss engine and generator, with the idea in mind that this would take care of the load requirements until at least 1930. The study showed that a 240- and a 360-hp. Diesel engine unit, giving a total of 395 kw., with the old Corliss engine unit as a stand-by, would take care of the peak-load conditions until about 1930, at which time it might be necessary to add another unit.

A study of installation costs showed that the addition of a 500-kw. Corliss-engine unit, a boiler, a superheater and condenser would total approximately $48,000. The 600 hp. in Diesel engines would cost approximately $61,000, including a new switchboard and the cost of rewinding the Corliss generator for three-phase current. This item was also included in the cost of the steam equipment.

The Calculated Savings

On the basis of probable energy output for 1928 it was estimated that the cost for fuel, lubricating oil and maintenance would total $11,240 per year for the Diesel-engine plant and $14,750 per year with the steam plant. No consideration was given to a possible reduction in labor costs, since it was expected that the personnel that had been operating the steam plant and the water-works would be retained. There was, then, a total reduction in operating expenditure of $3,510 for the year.

Another factor that had considerable bearing on the selection of the Diesel units, a factor frequently overlooked in comparing the cost of operation of steam and Diesel plants, was the expense of pumping water. It was estimated that the Diesel plant would require the

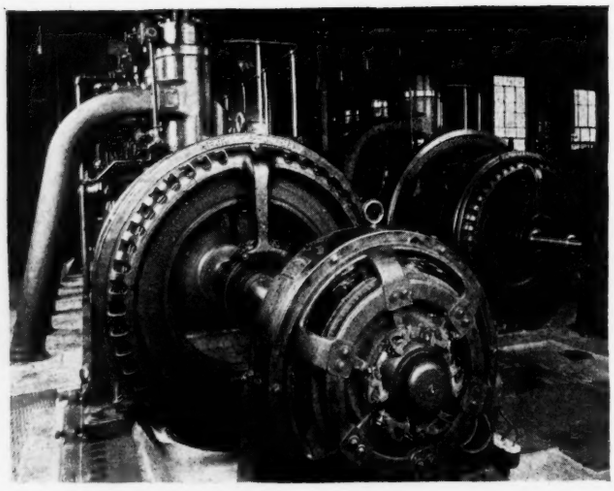


Fig. 2—Generator end of the 360-hp. unit

pumping of approximately 6,000,000 gal. of water per year for the cooling system, with a consumption of 26,280 kw.-hr. per year, while the steam plant would require 158,400 gal. of water per year, with an energy consumption for pumping of 131,400 kw.-hr. This, in itself, represented a reduction in expenditure in operating the Diesel plant of approximately $1,500 per year.

A study of the figures revealed that the total reduction in operating expense would amount to about $5,000 per year if the Diesel engines were installed, while the increase in investment would be $13,000 above the cost of steam equipment. Since this $5,000 saving appeared to be an excellent return on an investment of $13,000 and would rapidly retire the total investment, the decision was made to install the Diesel-engine equipment.

A contract was made with Fairbanks, Morse & Company, covering the engines and generators. As will be seen from the illustrations, the two units occupy a small floor space and are placed in the same room with the old steam engine. One interesting feature is the use of spiral-riveted pipe for the engine exhaust stacks. These pipes weigh far less than standard wrought iron or cast iron lines and, being galvanized, are expected to have a long life. The diameters are extra large to enable the stack volume to act as a dampener to the exhaust noise.

The installation has met the expectations of the engineers, as to operating costs. For example a month's operation gave the following results:

Kilowatt-hours generated	100,060
Fuel oil consumed, gallons	10,864
Lubricating oil used, gallons	208
Kilowatt-hours per gallon of fuel	9.2

Under the load conditions at the plant this showing is a most excellent one, and the cost of operation has been even less than was anticipated at the time the original study was made. The City of Ipswich now has a modern Diesel-equipped plant which can be expanded as load requires and which will have paid for itself out of the savings long before the useful life of the unit is over.

Fig. 3—The spiral-riveted exhaust pipes

Letters From an Oil Engine Operator

A Good Exhaust Line is Worth Money

Dear Ed: I think you had better get the idea out of your head of exhausting your engines up that old brick chimney. Every once in a while some fellow gets a bright idea about handling exhaust gases so as to do away with the silencers and the long pipe.

There is a plant over in Jersey where they took a notion that the regular exhaust pipes and silencers were not good enough and so they dug a deep trench between the engines, encasing it with concrete walls and top. They led the exhaust pipes into it, and the far end was open to a vent pipe back of the engine room.

For about six months all went well and not a sound was heard.

There were two-stroke-cycle engines and the exhausts had been a bit dirty at times. One day one of the scavenging pumps went A.W.O.L. and a cylinder stopped firing. The engine was working on a fractional load and the operator never noticed the lame cylinder. Of course the fuel pump was working and combustible gases were going into that big exhaust chamber under the floor. At the same time the other engines were exhausting a surplus of air, which went to the exhaust chamber along with the combustible gases.

A piece of hot carbon broke out of an exhaust port and went shooting into this mixture of vaporized fuel and hot air, and bang she went. The explosion blew her up. It ripped up about twenty feet of concrete floor and made a fine mess of things.

They rebuilt the whole thing and added a sprinkling system, using the cooling water from the cylinder jackets to spray into the exhaust chamber. They drain the water off the bottom to the city sewer and they have not had a second explosion. The exhaust makes no noise and it appears to be a good system. However, they would have had still better results, if they had been willing to invest in a silencer. A good silencer will kill all exhaust noise.

About your brick chimney. It occurs to me that you do not know but what the pulsation of your exhaust will set up vibrations that will loosen up the entire structure and bring it down on top of you. If anyone can figure the tune of that chimney and guarantee you to be clear of harmonic vibrations, well and good, but my advice is for you to forget it and keep your silencers. If that chimney comes down, you will sure think you are attending an Irish family reunion. E. O. LESEID

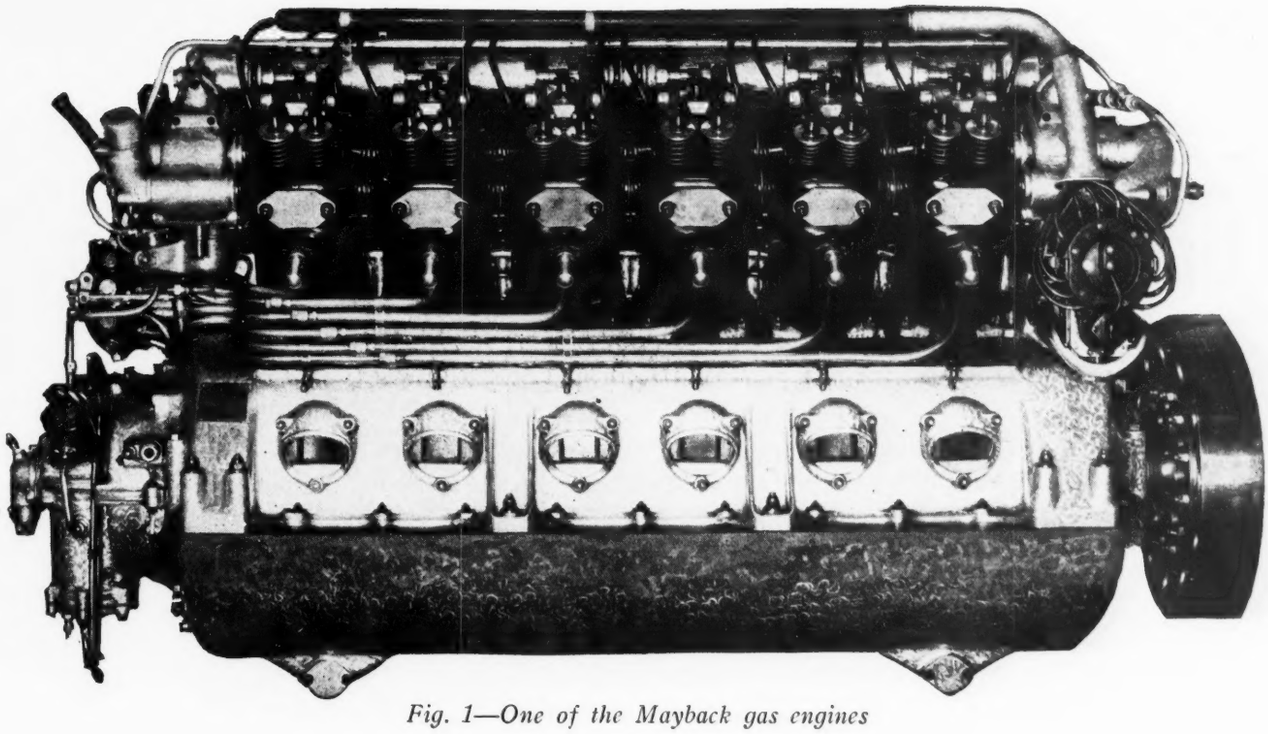


Fig. 1—One of the Mayback gas engines

The Heart of the Graf Zeppelin

The 570-Hp. Mayback Engines

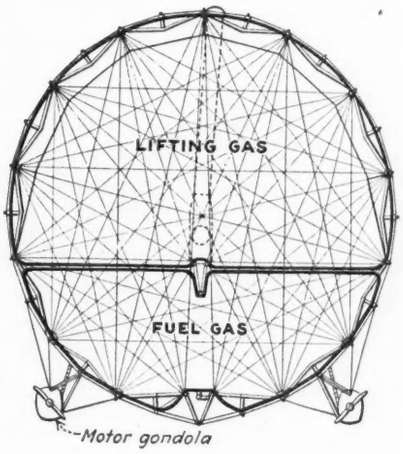
TO AN inquiry as to how the engines behaved on the Transatlantic voyage of the dirigible "Graf Zeppelin," one of the crew answered "We didn't know we had them along." So well did the five 570-hp. Mayback engines perform that none of the delays encountered were attributable to engine trouble.

In heavier-than-air craft engine troubles are frequent. The engine must be built as light as possible and at the same time must function continuously since the ability to remain in the air depends upon the continuous operation of the power plant. In designing the Mayback, engineers were able to insure almost perfect performance by running the engine at a slow speed and building it heavy enough to withstand the airship service demands.

Each of the Mayback engines has 12 cylinders, 5.5 bore by 7-in. stroke, carried in two rows, making a V-type unit. At 1,600 r.p.m. and at an elevation of 1,000 ft. the engines are rated at 550 hp. With a weight of 2,450 lb. this works out at 4.4 lb. per horsepower, about twice the weight of an airplane engine.

It is estimated that the engine should operate 2,000 hours before overhauling is necessary. This advantage over the lighter-weight engines is attributable, in part, to the use of roller bearings through the engine, with the exception of the piston-pin bearing. The pistons are of aluminum, and each has a separate connecting rod and crank bearing, in contradiction to the usual *V* design where the two rods have a common crank-end bearing.

As an airship is handled much like a steamship, the propellers must be reversed for astern movements. The Mayback engines are direct reversible. To accomplish this, a pneumatic gear shifts the camshaft to change the timing of the 36 engine valves. These valves consist of two exhaust and one intake valve per cylinder, driven through push rods and rockers from the single camshaft. These valves, as will be seen from the illustrations, are placed in the heads of the cylinders. Each cylinder and head is a one-piece casting made of gray cast iron with the liner cast with the cylinder jacket. Air for starting and reversing is obtained from a two-stage air compressor driven from the flywheel end of the engine through a cone clutch.



Motor gondola

The cylinders are water-cooled and this water is passed through the cooler shown at the right of the engine in Fig. 3. A current of air enters the gondola at the bow and, after passing through the cooler, is discharged through openings in the car.

The most unusual feature of the engine is that it burns "Blau" gas rather than gasoline. There is a slight advantage in heat per pound in the gas compared to gasoline, but

the basic reason gas is used is one that applies only to a dirigible.

If a dirigible is inflated with its lifting gas, say hydrogen, so that it will rise to the desired height when no fuel is aboard, it is necessary to inflate further to permit the cargo of gasoline to be taken on. As the vessel

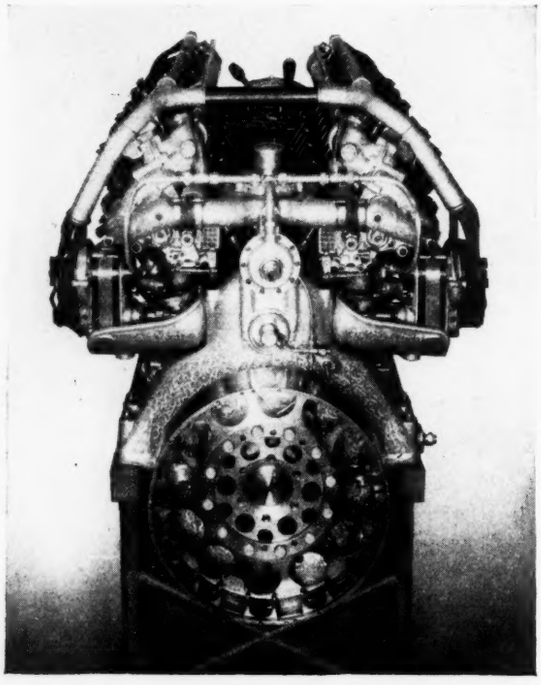


Fig. 2—End view of the Mayback engine

proceeds on its voyage, the fuel is consumed and the vessel has too much lifting gas. This means that the vessel will rise to a greater height unless some hydrogen is vented to reduce the buoyancy or some other compensating method is used.

As the amount of water vapor formed by the combustion of a pound of gasoline is greater than the weight of gasoline, in certain dirigibles suitable condensers have been attached to the engine's exhaust lines to condense and collect this water. This enables the vessel to have a balance between weight and buoyancy at all times, for a pound of water is collected for each pound of gasoline consumed. This plan, however, entails expensive and heavy condensing apparatus, which decreases the net lifting ability of a given dirigible. It is also possible to compress part of the hydrogen charge into steel bottles, but this calls for heavy steel bottles and gas compressors.

In the "Graf Zeppelin" a different and more economical method was adopted. Blau gas, named for its inventor, Doctor Blau, is similar to the Pintsch gas used for lighting on many American railroads. This gas is obtained from gas oil by a cracking process and has a specific gravity of 1.08 as compared to air. By inflating a number of bags with this gas, the vessel buoyancy is not changed from what it is when unfueled. As the gas is consumed during the voyage, the air collapses the Blau-gas bags, and as the specific gravity is the same, no alteration in buoyancy occurs. The vessel can maintain the same net lifting ability throughout the voyage.

On the preceding page is shown a section of the dirigible with the lifting gas bag at the top and with the Blau-gas bag below. The Blau gas is taken by suitable conduits to each engine. In Fig. 2 the piping over the engine is the gas conduit. This leads to four carburetors, which are essentially gas valves with center spindles through which the gas enters to meet the streams of air. There are likewise four Bosch magnetos per engine.

It is often necessary to drop some ballast to obtain ample boyancy after a change in barometric conditions. This can be done by carrying water ballast in separate bags, and the "Graf Zeppelin" does have several water ballast bags. However, chief dependence is placed on a load of gasoline, which, when additional buoyancy is needed, is consumed in place of the Blau gas, by turning a three-way cock.

The "Graf Zeppelin" is 775 ft. long and has a maximum diameter of 100 ft. Its gas capacity is 3,707,550 cu.ft., making its net lifting ability 16 tons.

The dimensions were made as large as the present erecting hangar at Friedrichshafen would permit. The main gondola containing the control room and passenger quarters is constructed of duralumin and is directly attached to the rigid frame of the ship. The five gondolas for the engines are mounted at the sides of the airship, and the driving power is transmitted through the rods to the frame.

The keel frame with the central and the main walkways is plainly visible in the cross-section. These walkways are connected by vertical ventilating shafts, the wood and wire framework of which is shown near the center of the drawing. The ducts which are used to deflate the ship run above the main walkway. Alongside the main walkway the fuel, ballast, freight, baggage, mail, food, supplies

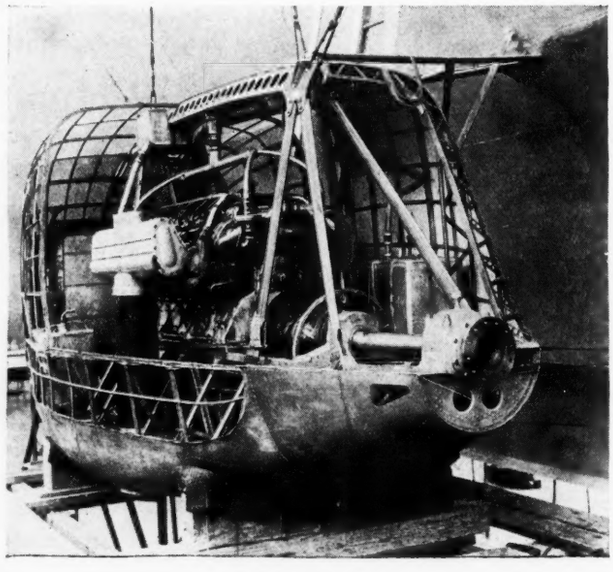


Fig. 3—The engine in its car

and repair parts are stored. The crew's quarters are also located here. The hydrogen cells and the cells for the fuel gas are drawn in the space they occupy when completely filled.

The upper cells contain the hydrogen, whereas the fuel gas is stored in the lower cells. ' Each of the hydrogen cells is provided with a relief valve placed above the central walkway. The vented gas passes harmlessly through suitably hooded ducts into the atmosphere. With the exception of the check valves in the outlet connection to the engine, the fuel-gas cells are not fitted with any other automatic valves. Protection against overpressure is afforded by the upper-cell relief valves.

*Desirable Fusion Temperatures of Coal Ash and Influence of Sulphur**

By A. Bement

MANY coal users seem to be of the opinion that the sulphur content is a controlling factor governing the fusion temperature of the ash and that high fusion temperature of ash is a desirable characteristic under all conditions. These opinions and beliefs are naturally exploited by coal companies that produce coal of low sulphur content as well as coal containing ash that melts at a high temperature.

Low-sulphur and high-fusion-temperature advocates have held the stage so long that their opinion is generally accepted, even by those who may produce coal that does not possess these assumed desirable characteristics. The result is that in coal sales talk one group exploits these features, while the other endeavors to avoid such subjects; therefore, it may be well to examine the facts. To show the responsibility of sulphur in controlling fusion temperature, the accompanying curve has been plotted from data presented in an article by W. D. Langtry, in the Jan. 31 issue of *Power*. In this it appears that there is a fusion temperature range of 1,900 to over 2,900 deg. of ash from coal that carried less than one per cent sulphur. A sulphur content of 0.6 per cent was accompanied by a fusion temperature under 2,000 deg., while with 0.9 per cent sulphur the ash melted above 2,750 deg.; with 4.30 per cent sulphur the ash melted at 2,400 deg. The range of tests under one per cent sulphur may be considered as showing that sulphur content bears no direct relation to the temperature at which the ash will melt. The curve, however, shows a slight drop in fusion temperature with increase in sulphur. This cannot be considered as indicating that it is due to increasing sulphur, because as a general rule the higher ranges of sulphur are found in coal of the poorer grades, which also contain an ash content that more readily melts. The reason, therefore, for the drop in the curve is to be explained by the character of the ash rather than the sulphur content. If data had been available for the range between 4 and 8 per cent sulphur, of course it would have made the presentation more complete, but the data as presented certainly fail to show that sulphur has any influence on the temperature at which the ash melts. Coal containing ash that melts at a low or medium temperature is often not favored, as its use tends to clinker production. Whether clinker production is a desirable characteristic or not depends on conditions and on the kind of furnace equipment in which the coal is burned. It should be realized, however, that efficient use of coal implies that it be burned with a high temperature of combustion; high temperature of combustion produces high furnace temperature, and high furnace temperature melts ash and produces clinkers. It is therefore apparent that the modern trend in power production tends to melting the ash. The coal available that contains so refractory an ash that it will not melt at the temperature prevailing with efficient combustion, is so small in amount that it is a minor factor in the general problem. Therefore, if the tendency is for most or practically all ash to be melted, it may be a matter of little or no importance at what temperature it does melt, so that in many cases the real problem to be solved may be the selection and use of furnace equipment that will handle coal in which the ash must necessarily be melted. On the other hand, under certain conditions trouble may be experienced owing to the ash not melting at sufficiently low temperature. The foregoing statements may be illustrated by cases in practice.

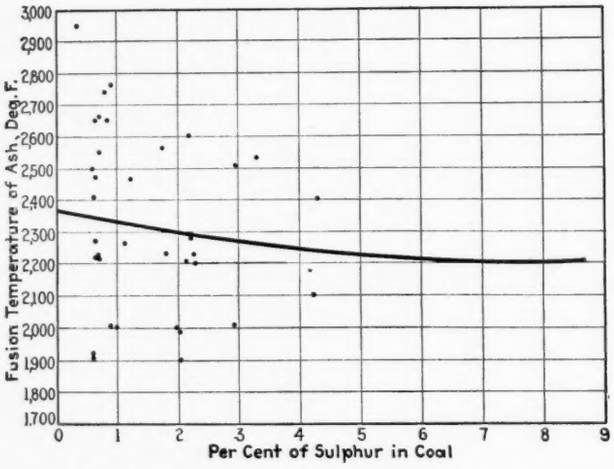
Available data seem to indicate that sulphur has little or no effect on fusion temperature of ash. Numerous cases are cited where low fusion temperatures are desirable, and in the selection of fuel the author points to the desirability of approaching the problem from the viewpoint of handling the ash.

Often the large multiple-retort underfeed type of stoker cannot be operated at high efficiency unless the coal used contains a very refractory ash, because the fuel bed necessarily carried does not allow the clinker to be fed out of the active fire, where it may cool and be dumped out without adhering. If coal containing ash that fuses be used, it may be necessary sometimes to carry a short fire and give the clinkers a chance to cool. This may result in lower efficiency and a tendency for the ends of the grates to become burned. On the other hand, with

*In *Power* for April 8, 1924, page 561, J. A. Murray showed from over a thousand analyses that for coals from certain fields, the chance of getting a coal with a fusion point of its ash above 2,500 deg. F. decreases as the sulphur content of the coal increases. —Editor.

the small single-retort underfeed stoker the ash appears in the form of a hot clinker at the top of the fire, from where it is forced to each side, becomes cool and causes no trouble.

In Wisconsin, where coal from the Eastern fields is available as well as that from Illinois, a corporation operating a considerable number of the better type of small single-retort underfeed stokers uses Illinois coal in preference. One of the principal reasons is that the Illinois ash melts to a good clinker, while the Eastern ash generally does not produce clinker. The plant engineer has said that they do not want to use any coal that does not produce clinker, because the ash can be best handled in clinker form. The practice is to remove the clinker



Sulphur has little effect on fusion temperature of coal ash

as it accumulates on the side dump grates, through the furnace doors by means of a hook. The side grates are not dumped. In this way no fuel is lost in the ashpit and the fire is not disturbed.

A company operating two plants in Michigan, one equipped with hand-fired shaking grates and the other with one of the single-retort underfeed stokers, used small nut-size coal from southern Illinois during the War period, with no trouble. Later, with changed conditions, they went back to an Eastern source, but having realized the advantage of the nut coal, sought the same preparation in Eastern coal. The only available supply of this size was from a field that produced a coal of less than 4 per cent ash, less than one per cent moisture and B.t.u. in accordance, but containing a particularly unfavorable ash. The result at the hand-fired plant was that the melted ash ran into the grates between the bars, so that the plant was immediately shut down and could not operate with the coal. The supply was changed to mine-run coal from another source. The engineer then went to the stoker-fired plant and asked the fireman how he liked this nut coal that had given such trouble in the other plant. The reply was that "the coal could not be better." When asked what he got when he cleaned the fire, he said, "Nothing but hard clinker and little of that." After operating all day, as the factory shut down he opened the furnace doors and hooked out about a half a wheelbarrowful of clinkers.

A milk condensery in Iowa operating boilers at 250 per cent rating from about 8 o'clock in the morning until 4 p.m., using southern Illinois No. 3 nut coal, has operated all day with the CO_2 between 15 and 16 per cent without the furnace doors being opened, the grates dumped or the fire being touched. At the end of the run, after the plant is shut down, the night man cleans the furnace.

The manager of a plant equipped with single-retort underfeed stokers, when asked how often it was necessary to clean fires, said that they did not clean fires but pulled clinkers from the furnaces.

Sometimes the fusing temperature of an ash may be high, but not high enough to avoid trouble. At Minneapolis, Minn., a small underfeed stoker uses southern Illinois coal successfully by always making a clinker that can be easily handled. In this market a variety of Eastern fuel is available, but experience with one of the best known Eastern coals with a reputation for refractory ash, was not satisfactory. The ash melted only to a sticky mass that could not be handled. This furnace was driven to a high capacity, but the furnace temperature was just high enough to partly fuse the ash of the Eastern coal, while that of the Illinois coal made a finished clinker readily handled.

During the last summer in the latter part of the period in which mining was suspended in Illinois, a limited amount of Eastern stoker coal found its way to Chicago. With a certain large forced-draft chain-grate plant customarily supplied from Illinois, the cinders produced commanded a good market, but when resort was had to Eastern coal, the people who had bought the cinders declined to accept them, saying that they were not getting cinders, but ashes. The trouble was that in this furnace equipment the Eastern ash did not melt enough to make a good cinder.

During this same time one of the new pulverized-coal boiler plants had a similar experience. This equipment, provided with water walls, etc., is one from which the ash, discharged in molten form, flows by gravity from the furnace to the ashpit. When attempting to burn Eastern coal containing an ash that melted at a higher temperature than that of Illinois coal, difficulty was experienced because the Eastern ash did not become a fluid, but only reached a pasty condition, did not flow, and so gathered in the furnace.

Too often the selection of coal is considered only from the combustion point of view. Now coal is easily burned; one coal so far as its combustible elements are concerned, will burn practically as well as another. It might be profitable if the general problem was approached more often from the viewpoint of handling the ash that is associated with the coal.

It appears possible that with the extending use of pulverized coal the character of the ash will become an important factor in influencing furnace designs and selection. Some recent development has been toward the discharge of ash in liquid form. This implies the use of coal that carries an ash that will melt. It would seem that the character of the coal ash in the logically available coal fields should govern the type of furnace used.

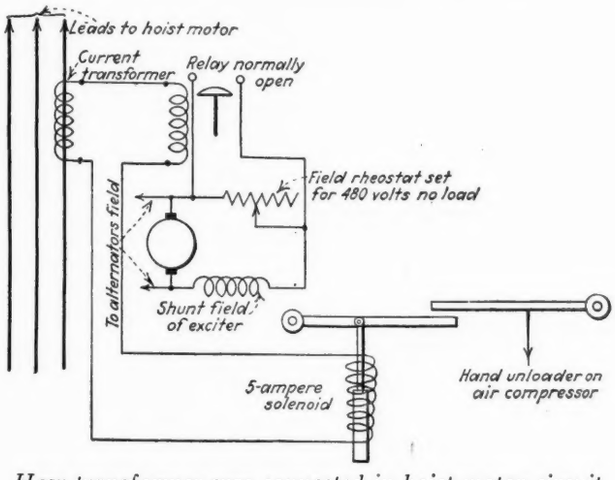
The author of the foregoing argues that, since efficient furnace temperatures are high enough to soften the ash in any coal, it may be better to seek an ash of low melting point and adopt disposal methods suited to completely fused clinker.

Right Out of the Plant

BOILED-DOWN EXPERIENCE PASSED ALONG TO THOSE WHO MUST SAVE MONEY, IMPROVE THE PRODUCT AND KEEP THE PLANT RUNNING

How a Small Generator Was Made to Handle a Heavy Connected Load

THE Ely Calumet Mining Company, located in the "wide open spaces" of Nevada, installed early last year a small alternating-current generator and connected this to a high-head waterwheel. Everything progressed nicely as long as the generator and waterwheel carried only the miscellaneous lighting and machine-tool load around the mine, but as development progressed, it was found desirable to install a small electric hoist. The rating of the hoist motor is approximately 10 per cent greater than the rating of the generator. Naturally, when the hoist was started there was difficulty with other apparatus and lines from low voltage and drop in speed.



How transformer was connected in hoist motor circuit

I happened to be at the mine shortly after the installation of the hoist and worked out a system, as indicated in the accompanying sketch, which entirely eliminates the former difficulties.

The system briefly is this: Into the circuit feeding the hoist motor was connected a current transformer whose full current rating was two-thirds that of the hoist motor, this current transformer operating an instantaneous, overcurrent, normally open relay, the contacts of which short-circuit the field rheostat of the generator exciter. The operation of the hoist motor on the first point was adjusted so that the relay would instantly trip, holding the field circuit closed and maintaining normal voltage until the acceleration period was over. When the current dropped, the relay opened its circuit, with a momentary decrease in voltage, and then everything operated normally.

This system worked so well that the user purchased a belt-driven air compressor and belted this to the opposite end of the waterwheel. By designing a solenoid and connecting it to this same current transformer to lift mechanically the air-compressor unloader during the heavy current peak, it was found that the user could operate not only the original load on the generator, but also the hoist and air compressor. This system has permitted a connected load of 73 kw. on a 30-kw. generator, all at a cost of less than $50 for control apparatus.

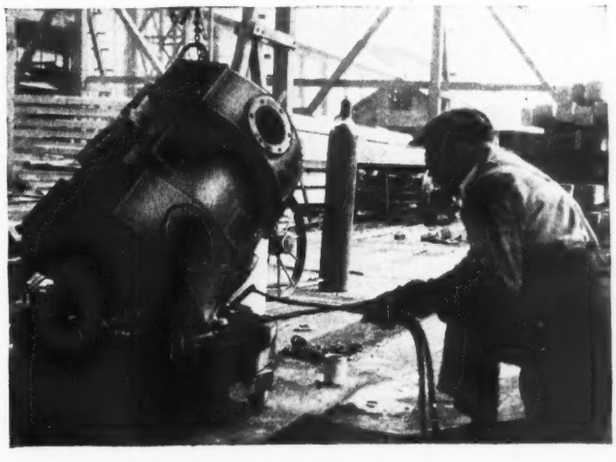
Salt Lake City, Utah. E. BACHMAN, General Electric Co.

Welding Large Air-Compressor Cylinder Effects Big Saving

SOME time ago a Western foundry had occasion to purchase a large air compressor from an Eastern firm. When the compressor was set up in the plant, it was found that it had been damaged so badly in transit that when put in operation the cylinder wall leaked.

Inspection of the damaged compressor showed that the water was coming from a crack in the cooling-water jacket with which air-compressor cylinders of this type are usually cast.

Here was a job for the plant welder. He immediately dismantled the compressor, and after first veeing the crack in the cylinder wall, which extended between the two intake air ports, he slung the casting on an overhead trolley and ran it out into the yard. Next, a small brick preheating furnace was built under the suspended piece. A charcoal fire was lighted and the preheating flames confined to the damaged portion. After sufficient heating of the cast-iron piece, welding was begun. A good quality of cast-iron rod and flux were used. The job was completed in a few hours without difficulty.



Cracked end of cylinder was preheated, then welded

Estimates of the amount of time and money saved in this repair job were gratifying. The plant suffered only a few hours shutdown, and the total repair cost was but a trifle over twenty-five dollars. Under the old method of scrapping and replacing with new parts, a delay of several weeks would have been entailed and an expenditure of several hundred dollars for a new part.

New York City. A. P. DUNCAN.

An Economizer Explosion

AN EXPLOSION that wrecked an economizer recently occurred in a large mill. The explosion was due to water hammer brought about by the careless operation of the flue dampers. The economizer worked in conjunction with a Lancashire boiler generating steam at 160 lb. After the mill was shut down for the day, the boiler fires were banked and the flue dampers at the back of the boilers were closed. Instead of the economizer bypass damper being opened, this was left closed and the inlet and outlet dampers to the economizer were left open, which permitted the gases to circulate through the economizer.

On raising steam the next morning, the main boiler dampers were opened, the draft being intensified by running an induced-draft fan. As the inlet to the economizer was still open, the hot gases from the furnace circulated through it, the gases being allowed to pass through the economizer chamber for about two hours without any water being circulated through the tubes. During this time the tubes became overheated and, as the feed valves to the boiler were not open, steam was formed in the tubes and headers at the hottest end of the economizer. Then when the engine was started and the feed check valves opened, the incoming feed water and steam in the pipes caused violent water hammer, which did the damage.

Such mishaps as these could be avoided by clearly marking the various dampers to indicate their position and by posting notices at the various dampers and feed valves indicating how they should be operated.

Brentford, England. W. E. WARNER.

Balancing Ways for Small Rotors

SOME time ago I had an occasion to use a set of balancing ways, and as our shaper was not large enough to plane the length desired, I could not see why

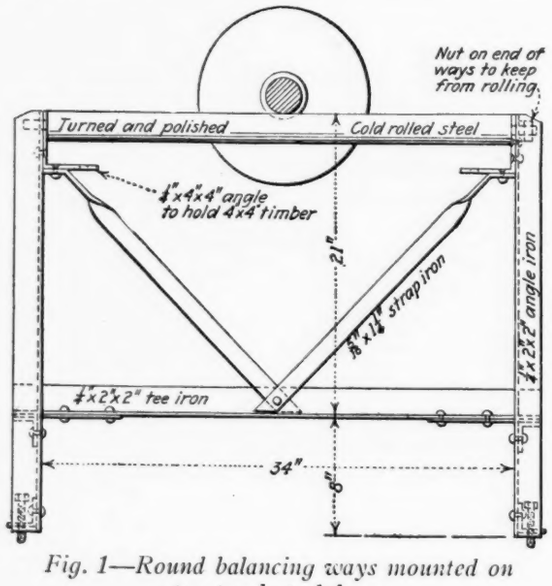


Fig. 1—Round balancing ways mounted on structural steel frame

the same results could not be obtained with round ways placed on sawhorses or angle-iron frames.

I turned the round ways on lathe centers and gave them a high polish. Then the idea struck me to make the horses suitable for other purposes as well by replacing the balancing ways with a piece of 4x4-in. square oak. The details of construction and dimensions of the ways are shown in the illustrations, which are self-explanatory.

The four jackscrews in the baseplate makes it easy to

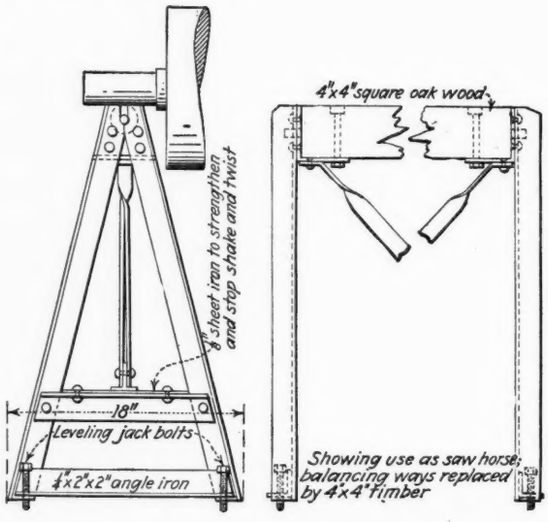

4"x4" square oak wood
¼" sheet iron to strengthen and stop shake and twist
18"
Leveling jack bolts
4"x2"x2" angle iron
Showing use as saw horse; balancing ways replaced by 4"x4" timber

Fig. 2—Balancing ways replaced by oak timber

level the ways and keep them solid. The horses, or frames, were made from odd pieces of angle iron cut to shape and riveted together.

Horses, or trestles, of this kind are, of course, suitable only for comparatively light work, but there are generally a multiplicity of uses around a power plant to which horses of this size and strength can be put, more, probably, than those of much heavier construction.

Glenwood Springs, Colo. C. V. LINDSAY.

What Do We Mean by Inches of Vacuum?

THE custom of measuring vacuum in terms of inches of mercury, starting with atmospheric pressure as the zero, is subject to certain objections. This is particularly true when the vacuum is high. In the first place, the zero is a constantly changing quantity, subject to barometric irregularities. In the second place, the standard of reference, the 30-in. barometer, is seldom attained under ordinary conditions. If these factors are not carefully measured and recorded at the time of observation, the data lose a great deal of their value and are likely to be misleading.

When the vacuum is high, one is usually interested in the absolute pressure rather than in the difference between the pressure and that of the atmosphere. Under such circumstances the zero at atmospheric pressure becomes increasingly awkward. To refer, for example, to a vacuum of 29.85 in. may justify the conclusion that the absolute pressure in the vacuum chamber was about 0.15 in. of mercury. On the other hand, to report the performance of a vacuum pump or similar device in terms of inches of vacuum, carries with it, all too often, the uncertainties resulting from incomplete knowledge of the conditions. Where a high vacuum is to be measured in the condenser of a steam turbine, for example, it is much more satisfactory to have the information in terms of absolute pressure. RALPH G. DEMAREE.

Pasadena, Calif.

As the Other Fellow Sees It

WHERE THE MAN WHO AGREES OR DISAGREES WITH AUTHORS OR EDITORS HAS A CHANCE TO SPEAK UP

Improved Pistons for Small Steam Engines

ACCORDING to the illustration and the description of the improved pistons for small steam engines which appeared in the Oct. 2 issue, the clearance space would be increased at both ends of the cylinder, but mostly at the head end. While a light piston would undoubtedly be an improvement, it would seem that a hollow piston of the original outside dimensions would decrease the expense and maintain the original efficiency of the engine, for one must resort to some means to retain the original clearance.

The effect of retaining the original clearance may be better explained by citing a case that once came under my observation: The engine of a coastwise steamer that was built during the Civil War, was of the type known as the long D-slide valve, a design that would probably give as short port as any valve of modern date. The engine was remodeled by its owners, a new cylinder of modern slide-valve design, with marine type of cutoff valves being put on. The designer, instead of measuring the length of the stroke, asked the captain the dimensions, which were given as 26 in. by 30 in., when the actual dimensions were 26 in. by 26 in. This mistake was not discovered until after the work was completed, when in putting in the piston, the workmen found that they had four inches extra clearance between the piston and the cylinder head. This difference, added to the original clearance, together with the longer port, had to be filled, at nearly boiler pressure, each revolution of the engine. One can readily see what this would mean in steam consumption.

The work of installing the new cylinder was a contract job; the engine was put together without any mention of the mistake, but after running the steamer a certain length of time, upon comparing the coal bill with the original, the owners were disappointed with results and ordered a new cylinder head, so as to remedy the defect. This restored the original clearance space but gave a port eight inches longer than was necessary.

East Hampton, N. Y. T. M. EDWARDS.

* * * *

Periodic Inspection of Electric Elevators

I WAS much interested in the article on "How to Make Periodic Inspections of Elevators," by John A. Dickinson, in the Aug. 14 issue. His suggestions in general agree with usual practice, but I doubt if a majority of elevator engineers would concur in his recommendation that the car safeties should be set with the car in motion at least once a year—certainly, not those engineers charged with responsibility for maintenance of the car as well as its safety devices. The argument for such a test, he states, is that it is required to check up on the condition of the governor cable and its fastenings.

It would seem that the condition of the governor cable and its fastenings can be satisfactorily determined by a careful inspection. The condition of the gripping dogs on the car safeties and their setting and the adjustment of the governor are usually the suspicious points, if such exist, which are difficult to check without such a test. A runaway or drop test is necessary to check the accuracy of the governor setting. Runaway tests are difficult on alternating-current machines, and drop tests require considerable preparation.

The setting of the guide-rail grip jaws on the car when in motion in a runaway or drop test usually results in more or less injury to the car, guide rails and gripping jaws. In a new equipment, properly installed, the guide-rail gripping jaws will set up evenly and stop the car in practically a horizontal position, but they will seldom do it on an old car, with the result that the car sling is thrown out of line, guide rails scarred and quite often the governor cable injured where it was gripped by the governor. The wires soon begin to break at the point of injury in an otherwise good cable. When the safeties have set a number of times, the car is considerably depreciated. I know of many cars that have been in use thirty years and are still in good condition. I doubt if they would be serviceable if they had been dropped once a year.

I have seen but little discussion of this phase of elevator inspection among elevator engineers, and no figures on the accidents that would have been avoided by such a test and that could not have been avoided by careful inspection. I should like to know the opinions of elevator engineers on this subject. H. C. RUSSELL.

Chattanooga, Tenn.

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Taking the Knock Out of a Pump

INFLUENCED by an article in a recent issue of *Power*, I decided that my experience of the last few weeks with a triple expansion cross-compound water pump might be of interest to other readers.

I was recently appointed city engineer and manager of the water department of the City of Greenville, Mississippi. Naturally, my first concern was the condition of the equipment, which I found to be in poor repair.

We immediately began repair work and the progress was rapid until work was begun on the pump referred to. This pump had a bad knock at the beginning of each stroke. It was our belief that the trouble was in the water end. Working under this impression we first examined the water end. The rubber valves were in bad condition, so we overhauled the entire water end and then started the pump. The knocking was as bad as ever if not worse.

With the water end in good repair we turned our attention to the steam end. The valves were all adjusted and new rings placed where needed, and the pistons tightened on the rods.

The pump was again started. The knock was still there. I was interested and concerned over finding some remedy for the trouble, and therefore began to study the problem from a new angle.

First, we noticed that the pump would knock only at the beginning of the discharge stroke. After it had made its suction stroke and began the discharge stroke, there was at first a quick motion of the plunger as if slipping; this was followed by the knock, and then motion was slower and smoother.

From this observation we were satisfied that the trouble was in the water end entirely, and it appeared that something was causing the intake valves to remain open until the forward motion of the plunger built up sufficient head to close them. After further observation, we decided that the pull of the pump caused a velocity head in the intake pipe, and this prevented the valves from closing by action of the springs alone.

I felt that there must be some means of overcoming the effect of this head, and decided that an air chamber in the suction line would be the remedy. We had an air chamber made of a piece of 12-in. pipe 8 ft. long. This was placed within five feet of the pump, and gave a cushion of about five feet when the pump was at rest.

The pump was again started, and this time there was no knock or noise, only the surge of the water in the air chamber. The discharge was as steady as this make of pump can be expected to give.

Greenville, Miss. F. E. HALL.

* * * *

Will Someone Explain the Refrigerating Code?

DECEMBER 13, 1927, the Board of Aldermen of the City of New York adopted an ordinance relating to refrigerating systems which is being put into effect as fast as possible.

One of the provisions—section 224—calls for pressure relief valves on receivers, shell-type evaporators and shell-type coolers. In section 226 it also provides for a safety valve on each compressor discharge and generator. This is as it should be, because of the danger involved in the rupture of a vessel containing ammonia, as that is the common refrigerant and the only one we will consider at this time.

Section 222, which is entitled "Testing," provides (for ammonia) a test pressure of 300 lb. on the high-pressure side, and on the low-pressure parts 150 lb. with safety valves and 225 lb. without safety valves. Now just what is meant by a safety valve on the low-pressure side? Does the fact that a shell-type cooler is provided with a safety valve come under this ruling and determine that the test pressure need only be 150 lb. on all low-pressure apparatus and piping instead of 225 lb.?

Then again the test pressure called for on the high side is 300 lb. While the older systems have safety valves set to discharge at 300 lb., the newer installations use, as a rule, 275 lb. as a maximum. It would certainly not be considered good practice to raise the pressure to 300 lb. even if the setting was at that figure, and run the chances of starting a leak through the valve, while to test with 275 lb. setting would require blanking off the safety valve entirely.

To test a plant now in operation brings another question to my mind. It is of course easy to shut off the ammonia condenser cooling water and run up the head pressure to any desired amount, but how about the low-pressure side? What is the best way to get the test pressure of 150 lb. on the low side of the system? Reversing the operation of the compressor and pumping from the high side to the low is a rather slow proposition if you are endeavoring to build up the pressure on the low side, and for a plant that has to keep going it is not practical. From the wording of the Code apparently no inspectors from the fire department are making the tests, so that possibly no standard test method has been evolved. The easiest and quickest method to get the desired pressure on the low side is to reverse the compressor and allow it to act as an air pump, drawing air from the room and compressing it into all the apparatus and piping on the suction side. This can be done safely by using a cold compressor and running it slowly. The main objection is that it will take probably six to eight hours to purge out the air.

While the Code is not explicit as to who is to test the apparatus and piping, it is no more than natural to assume that it should be a disinterested party.

There are other questions that can be raised, but I mention these as I believe an article explaining the "workings" of the Code would be extremely valuable to operating engineers. In fact a general discussion and criticism of the whole subject would straighten out many difficulties. WARREN D. LEWIS.

Montclair, N. J.

* * * *

Make the Steam Accumulator Part of the Boiler

IN AN article entitled "Make the Steam Accumulator Part of the Boiler," in the Oct. 2 issue, the author proposes to increase boiler and furnace efficiency, but loses sight of another loss that his plan would involve. He recommends the expansion of 450-lb. steam to the condenser pressure without extraction and a 150-lb. turbine taking steam from a fire-tube boiler.

Admitting some gain due to flattening the load curve and reduction in investment, let us consider what a straight 450-lb. plant can do when using steam extraction at process pressure. Instead of generating 150-lb. steam, suppose the 150-lb. turbine gets its steam supply from the exhaust of a 450-lb. unit. At 80 per cent stage efficiency a unit expanding from 450 to 150 lb. absolute would generate 21 kw.-hr. from each 1,000 lb. of steam used and the exhaust is still practically the equal of 150-lb. live steam, depending on the amount of initial superheat. To generate this current in a straight 450-lb. condensing unit would require an increase of at least one pound of coal per kilowatt-hour, and if 100 lb. of coal is required to generate 1,000 lb. of steam with a straight 450-lb. plant, the loss of this 21 kw. by product power per 1,000 lb. of steam will raise the coal to 121 lb. per 1,000 lb. of steam. Thus the fire-tube boiler must be 21 per cent more efficient than an equivalent amount of water-tube surface to effect this loss.

These figures refer to a plant where power requirements are great enough to require a condensing turbine for part of the power supply. In the case of a plant needing more process steam than the exhaust of the power units, Mr. Weaver's plan would be adaptable. But while it costs more to recover the heat in the gases below 1,300 deg. with an economizer and air heater than with Mr. Weaver's method, the heat so recovered is eventually delivered in the form of steam at 450 lb. and is easily worth twice as much as 150-lb. steam when considered for expansion to a process pressure of 40 to 50 pounds.

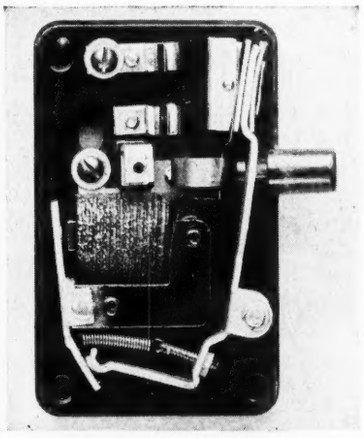
Springfield, Mass. A. F. SHEEHAN.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Protectoswitch for Small Motors

A SMALL circuit breaker known as the No. 1600 Protectoswitch for use on motors of $\frac{1}{4}$-hp. capacity or smaller, has been introduced by the



Protectoswitch with cover removed

Precise Manufacturing Company, Rochester, N. Y.

The dimensions are $3\frac{9}{16}$x$2\frac{1}{4}$x$1\frac{1}{2}$ in. The mechanism is mounted on a Bakelite base and is protected by a metal cover. Red and black push buttons extending through the case make it possible to use the breaker as a switch. For 110 and 250 volts alternating current the maximum current rating is 9 amperes, and for 240 volts direct current, 4 amperes. Fine adjustment for opening the circuit at any current between 3 and 16 amperes can be made by turning a screw stud inside the housing.

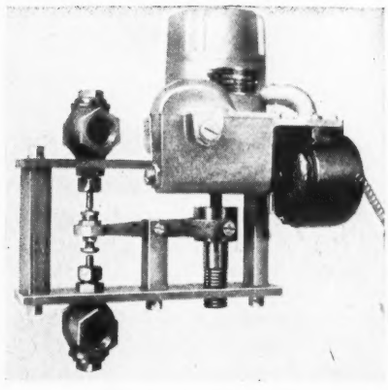
Torfoleum Insulating Material

A TYPE of insulating material, known as Torfoleum, is being introduced in this country by Pennrich & Company, 29 Broadway, New York City. This insulation, of which dried peat moss is the basic material, has been used in Europe for a number of years. It is especially suitable for use in ice making plants, cold-storage plants, for roof insulation and sound quieting and similar uses, where the temperature does not exceed 230 deg. F. It is made in sheet form $19\frac{1}{2}$x39 in. from 1 to 6 in. thick.

Some of the claims made for it are that it possesses the exceptionally low thermal conductivity of 0.27 B.t.u. per sq.ft. per hour per degree temperature difference per inch of thickness. It is non-capillary and the compression under a load of 1,764 lb. is only 0.03 in. per inch of thickness.

Motor-Operated Temperature Control

AN AUTOMATIC temperature control in which two valves (one for steam and one for water) are operated alternately by a reversible



Reversible motor operates steam and water valves alternately

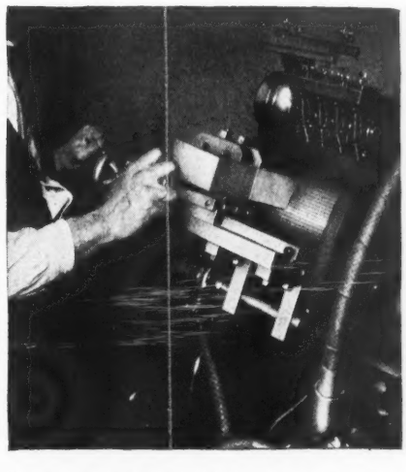
motor has been introduced by the St. Louis Motor Valve Company, St. Louis, Mo.

The motor is totally inclosed and drives a threaded shaft through a double-worm reduction gear mechanism. A lever, connected to the shaft and pivoted in its center, is arranged to operate the valves alternately. A limit switch stops the motor at the proper position. The complete control consists of a contact-making thermometer, of either the recording or indicating type, a relay panel and the duplex valve unit. The thermometer contains two contact points by means of which one circuit is made when the temperature is low and another when the temperature is high. The relay panel, which consists of two small contactors with series resistances, is operated by the instrument contacts. By the use of this relay the instrument contacts carry only a very small current and do not break an inductive circuit.

Improved Commutator Tool Rest

THE Ideal Commutator Dresser Company, Sycamore, Ill., has recently added to its line of commutator resurfacing equipment the "Perfect" tool rest illustrated. The tool has been especially adapted for the removal of long flat spots in commutators without the necessity of dismantling the machine or removing the rotor or armature.

The new rest is simple in construction and light enough to be easily portable. Bases are available in lengths from 6 to 28 in. varying by 2 in. Bases 14 in. or smaller have two supports, while the 16-in. or longer bases have three supports. The supports are L-shaped either 2 or 3 in. high or T-shaped 3 in. high



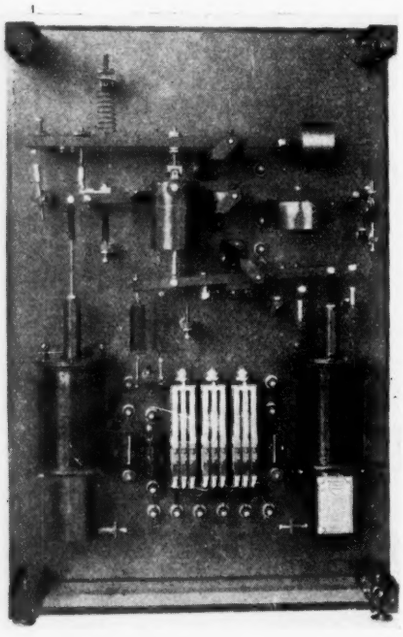
Tool rest with cutting stone mounted in place

for attaching to round brush arms. Flat supports can be substituted when necessary to attach to flat brush arms. Each base is fitted with a large-diameter wheel to facilitate easy operation of the cross-feed; also a screw in-feed adjustment. The machine is designed to take a 2x2-in. face cutting stone or smaller of any length.

Automatic Synchronizer

AN AUTOMATIC synchronizer, working on an entirely new principle, has been announced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

The synchronizer is designed to parallel two alternating-current sources when the phase-angle displacement between the alternating-voltage waves is zero and the frequency difference is below a certain value, depending on the particular application. It can be adjusted to operate only between definite frequency difference limits and to close its contacts at a certain phase advance



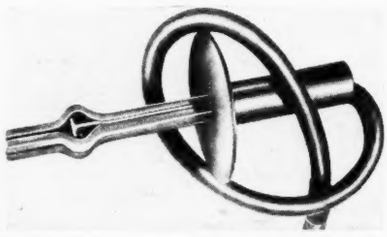
Synchronizer with cover removed

which will be proportional to the momentary frequency difference. The amount of advance, or the time elapsing between the energizing of the breaker closing relay and the closing of the breakers, can be varied by a single adjustment to suit varying conditions encountered in different circuit-breaker applications.

Electrode Holder for Metallic Arc Welding

THE Fusion Welding Corporation, 103d St. and Torrence Ave., Chicago, Ill., has recently brought out a new electrode holder for metallic arc welding designed to obviate one of the principal causes of electrode overheating, namely, improper contact in the electrode holder.

It is pointed out that the act of inserting the electrode in this new Model A holder automatically scrapes off any insulating material that may be present on the welding rod, insuring four clean points of contact and



Model A electrode holder

thereby minimizing the overheating of the electrode.

The holder is comparatively simple in construction, having no springs or moving parts. The jaws are made of a special copper alloy which, it is claimed, resists arcing and to which spattered drops of electrode metal will not stick. The holder is easy to load, and when the electrode has been inserted between the jaws, it may be placed at any desired angle to facilitate work in difficult welding positions. The act of inserting a fresh electrode automatically ejects the stub end of the old electrode without the welder touching it.

The Turbine Furnace

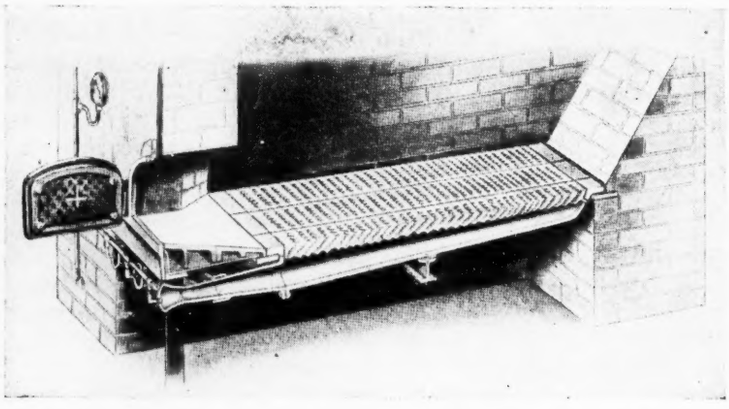
AS ITS name implies, the turbine furnace, which is adaptable for use under any hand-fired boiler, operates on the principle of the impulse turbine. The air trough running longitudinally with the furnace and forming the base of each grate section, is compared to the nozzle, and the fire bars to the blades of the turbine.

As will be plain from the illustration, each section is made up of three elements: An air injector, consisting of a minute steam nozzle discharging into a Venturi-shaped nozzle; an air trough of diminishing cross-section to assure an even flow of air for combustion throughout its length; and the grate section, consisting of a large number of individual fire bars of tapering section which are fitted into the top of the trough.

These fire bars project forward to catch the air, which is forced through narrow air spaces in the form of fine sprays, so that thorough diffusion is obtained. Intimate mixture of the air with the fuel makes for good combustion as well as for smokeless operation.

Valve control of the steam jets makes it possible to vary the draft as required and, if need be, build up the capacity beyond that provided by natural draft. Such a furnace will burn inferior fuels, so that it is possible to gain not only by improved economy and capacity, but also by the use of a cheaper coal. Owing to the use of small jets the amount of the steam used to produce maximum draft is claimed to be less than one per cent of the boiler output.

Grate sections are made 6 in. wide and up to 6 ft. long, as many sections being supplied as the width of the furnace requires. For a number of years this type of grate has been made by the Turbine Furnace Company, Ltd., of London, England, and several installations have been made in Canada. The license rights for its manufacture and sale in the United States have been secured recently by the Baker Valve Company, 1847 East 28th St., Minneapolis, Minn.

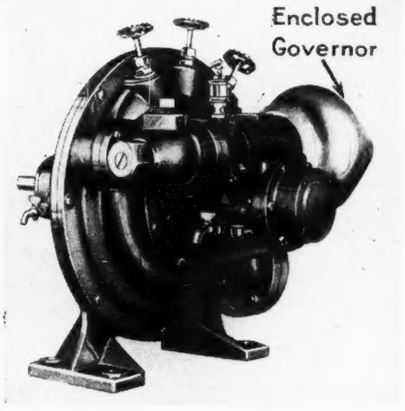


Turbine furnace as applied to a horizontal return tubular or water-tube boiler

Type TF Steam Turbine With Inclosed Centrifugal Governor

THE Coppus Engineering Corporation, Worcester, Mass., has recently added to its line of turbo blowers and steam turbines, the type TF steam turbine illustrated.

The turbine is being made in three sizes, 12-, 16- and 20-in. with live steam connections 1, 1½ and 2 in. respectively. The turbine casing and cover are of close-grain cast iron. The turbine wheel is cast of solid bronze and is carried on a shaft of large diameter and of comparatively short length. The shaft is supported by two ball bearings, the one next to shaft extension being of the double-row deep-groove type, and the one at the other end of the shaft being a double-row self-aligning type. The bearings are mounted in separate housings which are connected to the turbine casing by separate bearing



Type TF turbine

yokes. The turbine wheel is of the two-row velocity-stage impulse type with stationary reversing sector between the two rows of buckets. The standard direction of rotation is clockwise when facing the turbine from the shaft extension. Counter-clockwise direction of rotation can be provided upon request.

The type TF turbines are furnished either with or without constant-speed governor. The governor is of the centrifugal type and is driven by a worm gear from the turbine shaft, the gear being mounted directly on the governor head. The governor is fully inclosed by an aluminum guard. Provision is made for changing the speed while the machine is in operation. It is pointed out that owing to the slow speed at which the governor runs, it gives the valve a longer travel for a given variation and thus more stable regulation. When desired the turbines can also be equipped with an excess-speed safety trip.

"Jiffy" Gun for Cleaning Condenser Tubes

A COMPACT, light-weight gun designed especially for shooting rubber plugs through condenser tubes, has been brought out by the Liberty

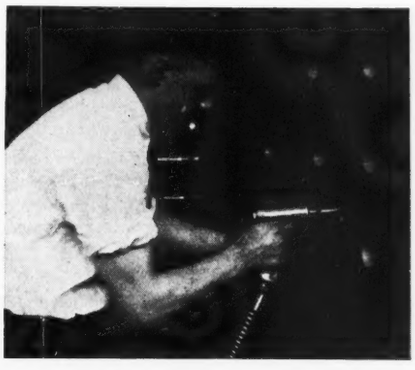


Fig. 1—The "Jiffy" gun in operation

Manufacturing Company, Jeannette, Pa. Fig. 1 shows the gun in operation and the partial view Fig. 2 shows its constructional features.

As shown in the illustrations, the nozzle *A* of the gun is attached directly to a piston *B*. When not in use, the piston is held in the closed position by the spring *C*. When the nozzle is pressed against the end of a tube, the piston slides back, allowing water or air to flow through ports into the piston, and hence through the nozzle into the tube. Leather washers are used on the piston to prevent leakage. When in use the nozzle seals

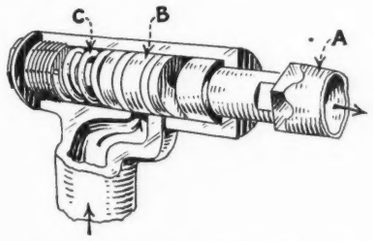


Fig 2—Sectional view of gun

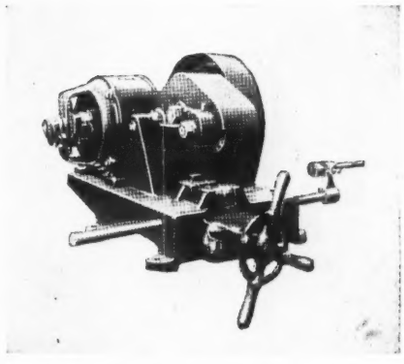
the end of the condenser tube, and the air or water pressure is directed against the plug.

The operation of the gun is entirely automatic, no valves or cocks being used. The plug is inserted in the tube, and the gun nozzle is pressed against the tube ferrule, which automatically releases the air or water pressure to the tube. As soon as the hand pressure on the gun is released, the spring forces the piston forward, cutting off the pressure.

The body of the gun is made of aluminum and the weight is approximately four pounds. It can be operated either by compressed air or water at a pressure as low as 50 lb. The tapered nozzle makes it suitable for use in all tubes ranging in size from one-half to one inch outside diameter. For tubes not in this range a special nozzle can be furnished.

Power Pipe Cutter With Cutter Mounted on Movable Arm

A PORTABLE production machine for cutting off pipe and tubes from ¼ to 2 in. in diameter, designed to speed up this work, has been introduced by the Oster Manufacturing Company, Cleveland, Ohio.



Front view of motor-driven pipe cutter

The cutter disk contained in a movable arm is brought down on the pipe, which rests on rollers, thereby varying from the usual method of raising the rollers and pipe to the cutter disk. The action of the arm holding the cutter disk is controlled by a screw feed and handwheel, giving compound leverage on the disk.

The machine is equipped with a length gage which can be set to cut any length nipple from "close" to 3 ft. on either side of the cutter disk. If a quantity of pipe is to be cut to lengths longer than 3 ft., an ordinary piece of pipe can be used with the standard stock stop as a length gage.

The new cutter can be furnished in either belt- or motor-driven types, a standard one-horsepower motor being supplied with the motor-driven type. An all-metal stand for the machine is also available.

Steam-Turbine Blading Materials

By A. Bodmer
Consulting Engineer, Paris, France

The author gives the results of study and research in turbine blading materials extending over more than twenty years. This account was prepared by R. H. Andrews, Paris correspondent of *Power,* on the basis of a profusely illustrated article in the April and May, 1928, issues of *Chaleur et Industrie,* which should be consulted by specialists interested in metallurgy.

RECENT progress in steam engineering seems to be turning definitely toward higher pressures, but high throttle pressures have a serious disadvantage. With the same total steam temperature and condenser vacuum the higher the initial pressure the greater will be the amount of moisture in the steam at the end of expansion, and this means a corresponding increase in fluid-friction losses in the lower stages of the turbine, not to mention the erosion of the turbine parts.

Two expedients have been considered to reduce the amount of moisture in the exhaust steam—resuperheating and increasing the initial steam temperature. The first method has already been widely applied in the United States, but has, as yet, found little favor in Europe, where interest is mainly concentrated on the second remedy, that of increasing the initial steam temperature.

A comparison of these two methods is beyond the scope of this article. It may be said, however, that resuperheating works, but requires a complicated and costly installation; whereas, high initial superheat has as yet received insufficient systematic study and application, but presents the advantages of simplicity, low first cost and higher thermal efficiency.

The idea of using higher steam temperatures is gaining ground both in Europe and in the United States, but it meets a great obstacle to its application in practice from the lack of confidence on the part of many operating engineers in the mechanical strength of superheater and turbine materials at these high temperatures, and particularly those materials available for the construction of the turbine parts exposed to direct contact with the steam, such as the fixed and moving turbine blading and the nozzles.

The object of this article is to review the materials used to date for turbine blading and to show that there is no longer any obstacle to the use of materially higher steam temperatures; for materials have been available for at least ten years which have proved their ability to withstand the action of high-temperature steam.

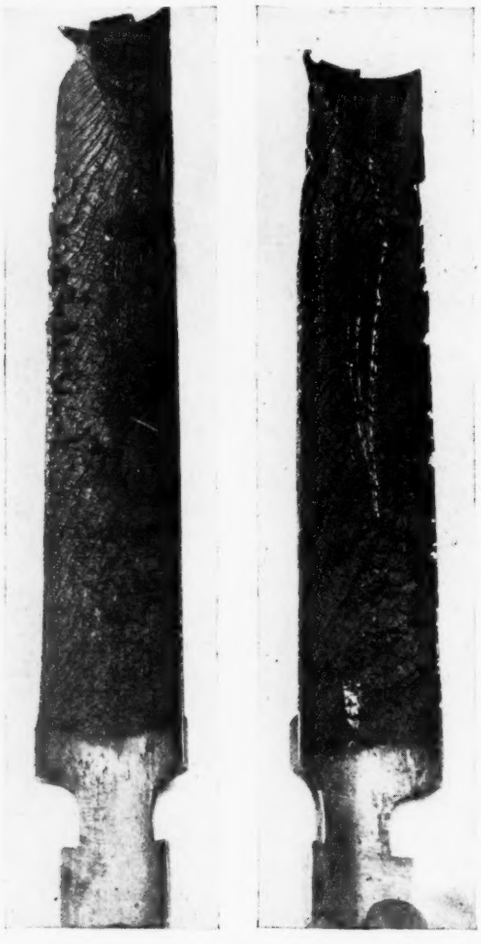


Fig. 1—Blades of 5 per cent nickel steel from a turbine receiving steam carrying traces of chlorine

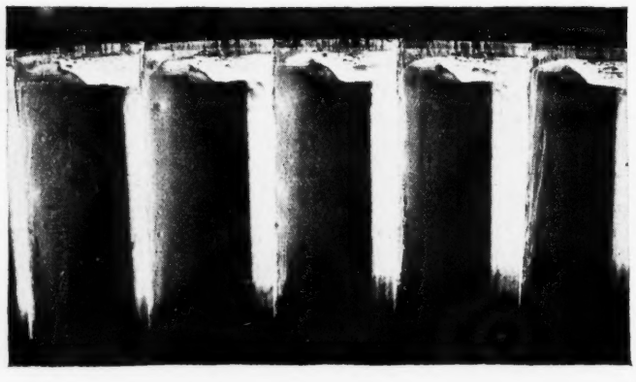


Fig. 2—Deposit on moving blades show inadequate boiler feed water purification

Principal Turbine-Blading Materials

In the early days of steam-turbine construction the principal materials used for reaction blading were bronze and brass, while carbon steels or low-content nickel steels were preferred for impulse blading. In recent years the use of these materials has not been discontinued, but many others have been tried out. The most interesting among these new materials are ferro-nickels, nickel brass (copper base), copper-nickel alloys (copper base), nickel-copper alloys (nickel base), steels of

high nickel or chromium content or containing both these elements, and ferrous alloys of high nickel and chromium content.

Brass has generally proved a satisfactory material for turbine blading, within certain limits. Its principal advantages are its resistance to chemical corrosion by steam carrying impurities, and facility of working. The principal defect of brass lies in its unsatisfactory mechanical properties, especially at high temperatures. It cannot be used above 400 deg. F.

Brass is still used by many turbine builders, but only for the medium-pressure stages of large units, or the medium- and low-pressure stages of small and medium-sized turbines.

Nickel Brass

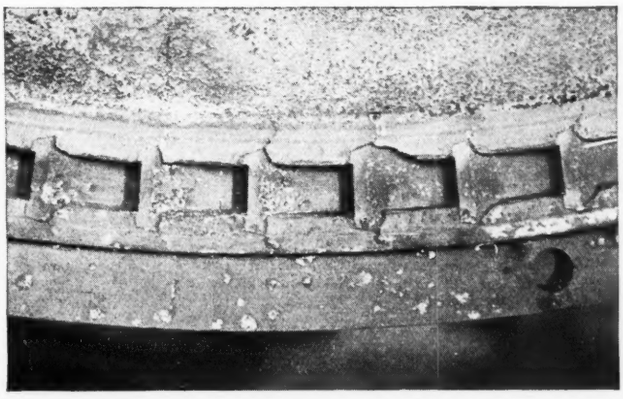
Nickel brass, or bronze, is now made in different compositions. In addition to its greater strength, nickel brass shares with ordinary brass the advantages of ease of working and resistance to corrosion by impure steam. But it also has the same defect, loss of strength at higher temperatures. Its use is therefore confined to medium- and low-pressure stages of turbines. As compared to ordinary brass, nickel brass finds a more extensive field in the direction of low-pressure blading, owing to its higher mechanical strength.

Copper-Nickel Alloys

A copper-nickel alloy consisting of about 80 per cent copper and 15 per cent nickel, with various other constituents, retains its strength better than nickel brass or ordinary brass, and may safely be used for temperatures as high as 650 deg. F. However, its use is practically limited to medium- and low-pressure stages. The mechanical properties of this alloy are about the same as those of nickel brass. It can be used only in turbines of moderate peripheral speeds.

Nickel-Copper Alloys

A nickel-copper alloy consisting of about 65 per cent nickel, 28 per cent copper, and the balance of various other metals, was developed some 20 years ago. It has certain features of unusual interest, principally its resistance to corrosive action. Its properties are not seriously affected by heat, provided the temperatures do not materially exceed 550 to 600 deg. F. This alloy becomes fragile by the effect of temperature alone, around 900 deg. F. Another limitation to the extensive use of this nickel-copper alloy in large modern turbines is its insufficient resistance to the erosive action of moisture in the steam.



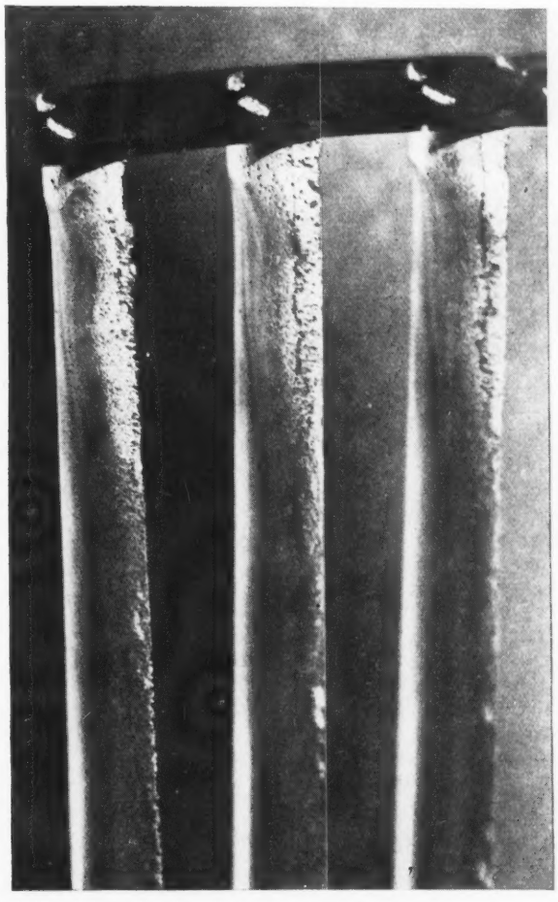


Fig. 3 — Diaphragm nozzles are often badly eroded by impurities carried by the steam

Fig. 4—These 5 per cent nickel steel blades show erosion after 9,100 hours' running

This defect limits the use of this alloy to turbines of moderate peripheral speeds.

The behavior of this nickel-copper alloy under the action of superheated steam is satisfactory, provided the temperatures are kept relatively low; but it does not seem suited to blading in the high-pressure stages of turbines using high-temperature steam. J. F. Saffy recently placed a sound bar of nickel-copper alloy under the action of superheated steam at 750 deg. F., for one month. At the end of this period a bending test revealed the presence of deep intercrystalline crevices, indicating advanced disintegration of the metal under the action of the superheated steam.

Ferro-Nickel Alloys

The behavior of this alloy in the presence of high-temperature steam recalls that of ferro-nickels. At about the same time that the above-mentioned nickel-copper alloy was first tried out for turbine blading, it was thought that the high resistance to oxidation and corrosion of ferro-nickels of 25 per cent, 33 per cent and even 36 per cent nickel content would make these materials suitable for the construction of turbine blading. The results were a complete failure. These alloys, though resistant to a considerable extent to oxidation by air or rain, are subject to rapid corrosion in the presence of steam.

Among all the materials used in recent years for steam-turbine blading, nickel steels containing approximately 5 per cent nickel are undoubtedly the most commonly used, both for high- and low-pressure stages, and especially for impulse turbines, and deserve special consideration. These materials have shown remarkable qualities for operation in superheated steam as well as in the low-pressure stages, provided the vacuum is not too high. In spite of this superiority, however, they are still deficient in ability to resist corrosion and erosion. Five per cent nickel steels are at present the most broadly used of all turbine blading materials; but this fundamental defect cannot be denied. In the action of steam upon this material, the most important factor is the steam temperature.

Recent Developments

Steam temperatures of 850 to 950 deg. F. still seem prohibitive to a great many operating engineers. Yet from the experience of the Langerbrugge central station in Belgium which has been operating at 850 deg. F. for several years; and from sporadic experiences such as that in the Gennevilliers central

station; also from the remarkable results of recent metallurgical research in the development of new turbine materials, it seems very probable that we shall shortly have at our disposal materials and processes allowing the construction of reliable superheaters capable of producing steam at these temperatures and at any pressures within the range of power practice.

Five Per Cent Nickel Steel

Most of the alloys that have served in the past for turbine blading, and those that are still in use, have been reviewed herein, and it may be concluded that not one of these, not even 5 per cent nickel steel, fulfills all the conditions required by modern practice.

The best of these materials is 5 per cent nickel steel, and various expedients have been tried to make it better yet. For example, attempts have been made to subject blades of 5 per cent nickel steel to some process for the purpose of giving them a protective coat of some unoxidizable or less corrodible metal, such as chromium, tin or zinc. A practical experiment was tried at the Gennevilliers station in Paris, where the blades in three last stages of a 40,000-kw. impulse turbine were tinned by immersion in a tin bath, and afterward carefully polished. The result was not satisfactory, for after three months' service the coat of tin had completely disappeared and the metal surface underneath was being rapidly oxidized.

To the best of the writer's knowledge the electroplating of turbine blades with chromium has given no appreciable results.

Effect of Heat Treatment

In order to give more effective resistance against erosion, several turbine builders have advocated the use of metals subjected to a heat treatment, for the purpose of raising their mechanical characteristics. A hardening effect may readily be obtained in this way, but the metal frequently becomes brittle; rupture of blades becomes more frequent, possibly owing to the formation of surface crevices during the heat treatment.

In the face of the exacting conditions imposed by modern turbine practice on the one hand, with ever-increasing capacities and higher peripheral speeds, and on the other hand by the failure of existing blading materials to fulfill the new requirements, a considerable amount of research has been undertaken with a view to replacing or improving these materials. Most of this work has covered ferrous alloys containing nickel or chromium, or both, in considerable proportions, and has given variable results.

Certain austenitic alloys containing about 8 per cent nickel and 18 per cent chromium have been presented by several concerns. Their excellent resistance to certain acids and to sea water gave rise in Germany to the hope that they might be used at least for stationary turbine blading. According to the latest information these alloys have not come up to expectations. They are extremely difficult to machine, and their heat-treatment is delicate.

The most important of these modern blading materials seem to be steels containing a considerable proportion of chromium, with or without a small quantity of nickel, and alloys containing a large proportion of both nickel and chromium.

Chromium Steels

Steel carrying 13 per cent of chromium was first produced in England and is now being manufactured in most countries producing special steels, under a considerable number of trade marks. These are of variable value, depending on the technique of the manufacturer. In France and some other countries they are called "unoxidizable," but this term gives an incorrect idea of their value. In reality these products offer a certain resistance to oxidation and to certain causes of corrosion; but these properties are dependent on the exactness of their process of manufacture and treatment, and considerable care must be observed in their use, so as not to impair their qualities.

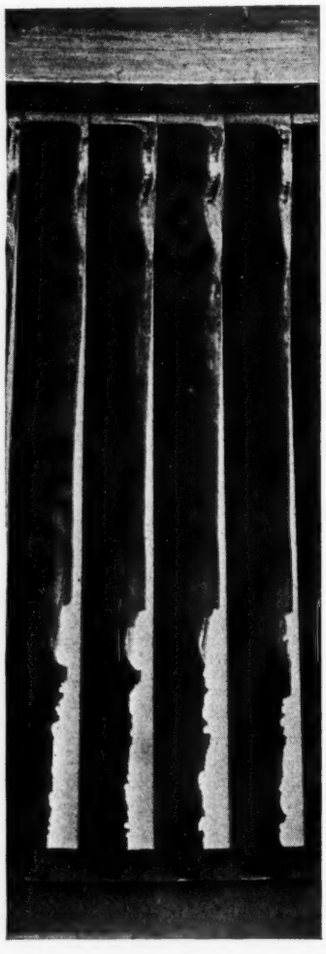


Fig. 5—Cracked blades of 5 per cent nickel steel

Two grades, or general groups of these products are produced; a hard grade and a soft grade. The resistance of the first to oxidation is dependent on the exactness of the heat treatment, consisting of quenching and annealing; and the perfection of the polish of the metal surface. Attempts to apply this steel to turbine blading have resulted in serious trouble. For example, in the case of the fixed blading the roots of the blades are buried in the cast iron or cast steel of the turbine casing during the casting of the latter; and it was found that the sudden heating and subsequent cooling of the casting process completely destroyed the effect of the heat treatment of the blading metal at the root of the blades, and that they became brittle and had lost most of their capacity to resist oxidation.

The soft grade does not require as strict observance of temperature conditions in its heat treatment as the harder grade, though its resistance to oxidation is still dependent on this treatment. But the maintenance of the most perfect possible polish of the surface of the blades is still necessary. This material is therefore suitable for the rotor blades. But the troubles encountered in the manufacture of the fixed blading are common to both grades. In fact, these troubles are inherent to all materials such as steels which become tempered and undergo molecular transformations under the influence of temperature changes. The contact of the hot molten metal with the roots of the blades produces molecular transformations that cannot be foreseen and leaves the metal in an unknown condition.

Effect of Surface Polish

Furthermore, as was seen above, the resistance of 13 per cent chromium steels and iron to oxidation and corrosion is dependent on the surface polish. Consequently, if this polish becomes impaired by erosion, the metal loses much of its resistance to oxidation. A special heat treatment is therefore often resorted to after the blades have been completely machined, for the purpose of hardening them and so making them less sensitive to erosion. However, this operation is costly and extremely delicate.

About twelve years ago there was developed in France a ferrous alloy containing a large percentage of nickel and chromium, and known by the name of "A.T.V. ALLOY." It is really 36 per cent ferro-nickel to which is added a sufficient proportion of chromium to correct the defects outlined above, and particularly its sensitiveness to intercrystalline corrosion under the action of steam.

Experience with "A.T.V." Alloy

The writer's first experience in the application of this alloy to turbine blading began in 1920, in the central station of the French naval arsenal at Toulon. The operating conditions of this station were particularly exacting. It was used mainly for stand-by service, most of the power needs of the arsenal being supplied from the system of a local hydro-electric power company. The generating units, four in number, were driven respectively by two 2,400- and two

3,500-hp. Zoelly impulse turbines. Furthermore, sea water is used for condenser cooling, and in spite of the utmost care in the upkeep of the condensers small quantities of chlorides leak into the condensate and are entrained by the steam.

The turbine blading, which was of 5 per cent nickel steel, gave considerable trouble. It was replaced every fourth or fifth year, and long before these replacements, the blades were so deeply cut along the edges and pitted by erosion and corrosion that the efficiency and general operation of the turbine were considerably impaired.

Experiments with ATV Alloy

The writer had proposed in 1916 to try the A.T.V. alloy; but the production of this material during the war was very small, and only in 1920 could the change be made. The first trial was made on the two 2,400-hp. turbines, the nozzle vanes of those stages closest to atmospheric pressure being replaced by A.T.V. In 1922 all the nozzles and rotor blading of the low-pressure stages of one of the 3,500-hp. turbines were replaced by A.T.V.

The chief engineer reported in 1924 that careful inspection of the turbines at that date showed no trace of corrosion or erosion of the replaced nozzles and blades. At the present time, after more than seven years of intermittent service of the most exacting kind, the nozzles and blading of the three turbines are still intact.

In 1919 the writer had already started a series of tests in the laboratories of the Société Alsacienne de Construction Mécaniques for the purpose of observing the resistance of various blading materials of French manufacture to erosion and corrosion. An expansion nozzle fed by a steam line with steam containing a slight amount of moisture was disposed so as to direct a steam jet, at the velocity of about 3,000 ft. per sec., against a pair of turbine blades fixed side by side. Each test lasted several days. The behavior of the A.T.V. alloy was in every case materially superior to that of every other alloy tested. Following these results, the Société Alsacienne and several other turbine builders have been developing the use of A.T.V. for fixed and movable blading, in all cases where corrosion and erosion are probable.

One of the interesting features of A.T.V. is that it can readily be used for fixed blading and nozzle vanes of impulse turbines. As previously mentioned, the roots of these vanes are buried in cast steel or cast iron. During the operation of casting, these vanes are subjected at their root, and in the case of the first-stage nozzles, which are very short, throughout their entire length, to high temperatures. These temperatures have no effect on the mechanical properties of the A.T.V. alloy. The micrographic structure of the alloy does not change, and it retains all its properties of resistance to corrosion and erosion.

Cast iron is materially more adherent to the A.T.V. alloy than to any other blading materials. Tinning of the roots of the blades before casting is necessary with most other steels, but not with A.T.V.

In a recent experiment 13 per cent chromium steel and A.T.V. were used under identical operating conditions, at the Gennevilliers central station.

When the last two 50,000-kw. generating units (Nos. 7 and 8) of this station were ordered, the specifications provided that all blading, fixed and moving, was to be of "unoxidizable" materials. The two units were built by different manufacturers. One of these chose as blading material 13 per cent chromium steel for the high-pressure stages, brass for the medium-pressure and the first of the low-pressure stages, and 13 per cent chromium steel hardened by heat-treatment after completion of the blades for the last of the low-pressure stages. The other manufacturer chose A.T.V. alloy throughout.

These two units have been in service for about one year. The A.T.V. blading, both fixed and moving, is still in perfect condition. At the last inspection this unit had operated about 2,700 hours, and no trace of either corrosion or erosion could be detected. During this period the throttle temperature, which should normally have been 700 to 720 deg. F., frequently exceeded 750 deg. F., while the vacuum in winter frequently reached 29.4 in., indicating a probable moisture content in the exhaust of about 12 per cent.

The other unit was inspected after 1,500 hours of service. In the high-pressure section many of the rotor blades of 13 per cent chromium steel were found to be more or less severely chipped, and several stages had to be rebladed. The brass blading of the medium-pressure stages was found in perfect condition with the exception of a few blades, both fixed and moving, that had been distorted by particles of metal from the damaged high-pressure blading. The moving blades of the low-pressure stages, which were of hardened 13 per cent chromium steel, were considerably eroded and slightly corroded.

Surface and Body Resistance to Corrosion

The essential difference between 13 per cent chromium steel and the A.T.V. alloy is that the former has a *superficial resistance* to corrosion and erosion, which is dependent on the surface polish; whereas the latter is equally resistant throughout to corrosion, and its uncorrodibility is entirely independent of the condition of its surface. Furthermore, temperature changes, even beyond the range of normal heat treatments of steels, have no effect either on the corrodibility or on the crystalline structure of the A.T.V. alloy; for it is mainly austenitic in composition and does not undergo any molecular changes with heating or cooling. This property is especially valuable in fixed blading, the roots of which are subjected to the temperature of molten cast iron during the casting of the casing.

Should power-plant practice so develop as to require considerably higher steam temperatures, the manufacturers of A.T.V. have another alloy, A.T.G., whose characteristics are still superior to A.T.V. at high temperatures.

Turbine Blade Materials

Brass: An alloy of low mechanical strength, impracticable for use in superheated steam owing to molecular instability; not to be recommended for low-pressure blading, owing to its lack of resistance to erosion. Generally used only for medium-pressure blading, provided peripheral speeds are not too high.

Nickel-Bronze and Copper-Nickel: Somewhat superior to brass; may be used for steam temperatures up to 650 deg. F. Insufficient resistance to erosion. Their mechanical properties, which are superior to those of brass, adapt them for use in medium-pressure stages.

Nickel-Copper: Almost unoxidizable at atmospheric temperatures, but questionable in the vicinity of 750 deg. F., at which temperature it is rapidly disintegrated by the action of superheated steam. Insufficient resistance to erosion.

5 Per Cent Nickel Steels: Excellent material for blading in all stages; stands up well in high-temperature steam, and resists erosion, provided the vacuum is not too high. Its main defect is insufficient resistance to corrosion; should never be used when salt water is used for condenser cooling.

25 and 36 Per Cent Ferro Nickel: Materials unfitted for use in steam.

13 Per Cent Chromium Steels: These materials can be used for high-pressure blading, provided the steam temperatures are not too high. They are imperfectly suited to medium-pressure blading, because they are not unoxidizable. Their unsatisfactory resistance to erosion does not adapt them for low-pressure blading. These materials must be used in the heat-treated state, therefore in an unstable molecular condition under variable temperatures.

Ferrous Alloys with High Nickel and Chromium Content: These materials stand up well under all steam temperatures within the range of turbine practice. Their resistance to oxidation and corrosion under conditions of turbine operation is apparently indefinite, even when chlorides and acids are present in the steam. Their resistance to erosion is excellent, even with very high vacua. In every station in which these materials have been used to date, their behavior is reported to be excellent.

Electric Boilers

Electric boilers have a real, though limited, economic application in the utilization of excess hydro-electric power that would otherwise run to waste. In most cases it would be economic folly to use electric boilers for the production of steam in appreciable quantities, since electricity purchasable at one cent per kilowatt-hour would be roughly equivalent to average coal at sixty dollars per ton, after making allowances for the differences in boiler efficiency. If coal produces electricity with an efficiency of 20 per cent, and this is used to produce steam, the over-all efficiency cannot exceed 20 per cent.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING

INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Power Service Problems Discussed at Southern Textile Exposition

Master Mechanics Division of Southern Textile Association Hold Meeting in Conjunction With Textile Exposition at Greenville, S. C.

APPROXIMATELY 125 members attended the meeting of the Master Mechanics' Division of the Southern Textile Association held at the Poinsett Hotel, Greenville, S. C., Tuesday, Oct. 16, in conjunction with the Southern Textile Exposition. G. T. King, superintendent of power, Lancaster (S. C.) Cotton Mills, and chairman of the division, presided. J. M. Gregg, secretary of the association, was present and introduced Mr. King. The meeting was devoted to an intimate discussion of questions which had been developed in advance by the officers of the division. Members who attended came from North Carolina, South Carolina, Alabama, Georgia and other southern states.

Voltage for Loom Motors

The first question discussed was: "What voltage would you prefer for operating motors directly connected with looms?"

As no formal expression of opinion was taken, it is impossible to state what view was held by the majority, but, judging from those who joined in the discussion, it was evident that the use of the standard Southern mill voltage of 550 was more in favor than 220 volts. The chief reason given was the cost of the heavier wiring required for the lower voltage. On the other hand, it was stoutly maintained by at least one member that there are mechanical advantages in the latter voltage which outweigh the extra cost and the slight loss in power.

This question led up to a discussion of the type of switches used on individual loom motors and it was the general opinion that a snap-switch was likely to cause trouble. It was particularly emphasized that the switch should be entirely enclosed.

Mill Heating Systems

Discussion of the best type of heating system for a cotton mill, both for economy and service, brought out such a wide variety of opinion that it is impossible to express what might be regarded as an average view.

This also holds true in connection with the discussion of the effect which humidifiers have on the temperature of the weave room during the winter months, especially on Monday morning when the mill is starting up.

Steam Reducing Valves

Probably the most animated discussion of the meeting centered around the question: "What type of steam reducing valve do you use and does it continue to hold pressure normal after use is discontinued on low pressure side of valve?"

Some members came out as ardent supporters of certain types of valves, but the opinion most frequently expressed was that a certain amount of trouble was to be expected from all types. The chairman of the meeting threw out an interesting thought when he stated that he had been experimenting for some time on having blow-out valves trimmed with monel metal, that is, the seats and the disks. He believes that, from his experience, this is going to prove a paying proposition. He also expressed the belief that the disk has a good deal to do with the life of the valve.

Barometric Condensers

Discussion of the question as to whether or not there is any danger of a barometric condenser flooding low-pressure cylinders of the engine brought out the opinion from one member that this is due to the bottom of the discharge pipe in the hotwell becoming uncovered. In this way alternate sections of air and slugs of water induce a pumping action which can result in the flooding of the cylinders. His suggestion for precaution against this was either to increase the size of the hotwell or to put the discharge pipe far enough down in the water.

Among other subjects discussed were the steam consumption of the slashers and the question of unnecessary junking of worn out machine parts.

The meeting was closed with discussion of several questions brought up by members in attendance. In addition, a set of problems was presented by John Fox, of the Duke Power Company, and these will be taken up at future meetings of the division.

Before adjournment, the meeting expressed its appreciation to H. H. Iler, past chairman of the division; to J. M. Gregg, secretary of the association, who has contributed so much to the success of the meetings; and to the Alabama delegation attending the Greenville session since members of this delegation were particularly active in the discussion.

Davis Inauguration at Stevens Institute to be Outstanding Affair

More than 300 colleges, universities, learned societies and educational foundations throughout the country have been invited to send delegates to the Stevens Institute of Technology, Hoboken, N. J., on Nov. 22, to attend the inauguration of Dr. Harvey N. Davis as president. Doctor Davis, hitherto professor of mechanical engineering at Harvard University, recently relinquished this post to C. H. Berry, formerly associate editor of *Power*.

Trustees of the Institute will tender a dinner to the educational delegates at the Hotel Astor, New York, on Thursday evening, Nov. 22, when Dr. Henry Suzzallo, formerly president of the University of Washington, a trustee of Stevens and of the Carnegie Foundation for the Advancement of Teaching, will preside, and President W. H. P. Faunce, of Brown University, will speak.

The inauguration ceremonies will occur on Friday, Nov. 23, at the Institute. At a scientific session in the morning of that day papers will be presented by Prof. John Johnston, director of research of the United States Steel Corporation, and by Robert A. Millikan, president of the California Institute of Technology, Nobel prize winner in physics and discoverer of cosmic rays. Dr. David Schenck Jacobus, a trustee of the college and past-president of the American Society of Mechanical Engineers, will preside over this session.

The formal inauguration will take place in the gymnasium of the college where from 1,500 to 2,000 people will be assembled to hear Doctor Davis' inaugural address and an address by A. Lawrence Lowell, president of Harvard University.

The Institute's engineering museum, which contains a remarkable collection of early automobiles, will be opened to the public, and a replica of the first successful steam locomotive to run on rails in America will be set up on a replica of the original track and operated on the day of the inauguration. This "steam carriage" was built by Col. John Stevens, the father of railroading in America, and was run by him on his estate at Castle Point on ground now included in the campus of the college.

Motion Pictures a Feature of The New York Power Show

A feature of the Seventh National Exposition of Power and Mechanical Engineering this year will be a motion picture program running through the entire week of the Show from Dec. 3 to 8 inclusive.

The films cover a wide field and run from one to five reels, some of them showing for the first time. The program consists of the following films:

"The Age of Speed"; "The Handling of Heat," showing the use of Norton Refractories in industry; "The Story of Vim Leather"; "The Manufacture of Timkin Steel Roller Bearings"; "Freezing Out Fires," which demonstrates the effectiveness of Fyre-Freez carbonic gas as an extinguishing medium as compared with foam or carbon tetrachloride; "Electrical Measuring Instruments"; "Controlled Heat," illustrating the control of fire and the transmission of energy in the form of heat to work for the comfort of man; "The Heat Thief"; "Controlling Fire in the Dip Tank"; "Power," showing the amazing growth in the use of power since it was first applied industrially about 150 years ago, traces the development of the steam engine from the first crude engines of Newcomen and Watts to those of the present time; "From Coal to Electricity"; "Conowingo," which shows the building of one of the important water power projects of the United States. Located on the Susquehanna River it is, in its initial development, second only to the plants at Niagara.

Study of Power Generation at Navy Yards

A considerable increase in the power demand is one of the outstanding indications thus far of a survey now being made by the Bureau of Yards and Docks of the power requisites of the various navy yards. In explaining this increase naval officers point out that the greater use of electric welding equipment has added materially to the power consumption. Another factor is the gradual substitution of electricially operated air compressors for steam-driven apparatus.

One of the principal reasons why the survey is being made, Rear Admiral Gregory, chief of the bureau, pointed out, is to standardize the methods of operation and accounting in practice at the various yards in orders to provide a basis for comparison. It is believed that if the power plants can be put into competition with each other as far as performance is concerned, the task of devising means for saving part of the $3,000,000 it now costs the navy annually to operate them will be simplified.

It is freely conceded that one of the most important questions to be considered in power economy will be the advisability of the power used from commercial power companies. The entire amount of central-station power now used is on the West Coast at the San Diego and Puget Sound naval stations. It is thought, however, that conditions are now such that power can be purchased advantageously at some of the Eastern yards. Whatever might be done in this connection the navy will protect and augment its power supply by retaining the use of its own equipment.

It has been found that the absence of the weight of rivets in electrically welded vessels is a considerable factor in promoting fuel economy. It is also pointed out that the two new aircraft carriers that will soon be placed in service will add materially to the power loads at the navy yards. These vessels will consume nearly five times the amount of power required on the largest battleship. When they are put up at the yards with their engines dead, they will be connected with the shore stations.

Felix Layat, resident engineer of the Chile Exploration Company, returning wth Mrs. Layat to Tocopilla, Chile. The company's 50,000-kw. plant, which he superintends, is 4,000 miles from a fuel source and in a drought and earthquake belt

Setting up the Brown-Boveri Unit at Hell Gate

Work of installing one of the largest generating sets yet manufactured is now in full swing at the Hell Gate station of the United Electric Light & Power Company, New York. This unit was made in Switzerland by the Brown-Boveri Company and was shipped disassembled from Antwerp by the steamship "Patagonier" some weeks ago. On the arrival of the steamship in America the machinery was transferred to a lighter and taken to the power plant for erection. The following description of the 160,000-kw. unit has been authorized:

This unit comprises a 75,000-kw., 1,800-r.p.m. high-pressure turbine and an 85,000-kw., 1,200-r.p.m. low-pressure element. It is designed for steam pressure of 265 lb. gage and 700 deg. F. total steam temperature. Two bleed points are provided—one in the outlet from the high-pressure cylinders and the other from the fourth stage of the low-pressure turbine. The condensate temperature is raised in the closed heaters to 210 deg. F. The primary valve of this turbine is wide open at 90,000-kw. and the secondary reaches the limit of its value at 130,000-kw.

The rotor of the high-pressure turbine is directly connected to an 88,250-kva. 60-cycle three-phase 13,800-volt generator and the low-pressure rotor is coupled to a 100,000-kva. generator which is operated in parallel with the high-pressure element. The low-pressure unit exhausts into a Westinghouse condenser of 137,500-sq.ft. surface.

There are three Springfield sectional header cross-drum water-tube boilers each rated at 2,000-hp. These boilers can evaporate 400,000 lb. per hour each. The superheater, which has a surface of 4,800 sq.ft., will raise the steam temperature to 730 deg. F. These boilers will use the unit-type combustion system as distinguished from the "bin" type. The combustion equipment for these boilers was furnished by the Combustion Engineering Corporation. The boilers have Murray fin-type water walls.

The economizers for the first two boilers for this installation have a surface of 26,126 sq.ft. each and are of Foster-Wheeler manufacture. The economizer on the remaining boiler is furnished by the Combustion Engineering Corporation and has a surface of 27,836 sq.ft. These boilers are also equipped with air heaters, each having a surface of 11,840 sq.ft.

Fourth Power Show at Chicago to Group Allied Exhibits

The forthcoming Power Show at Chicago to be held from Feb. 12 to 16, 1929, is creating more genuine interest among power men than any so far held. Reports from the management indicate that the entire Coliseum will be filled with exhibits of diverse character so that the visitor will have an opportunity of seeing and comparing machinery of many types and makes. One of the new features of the show will be the coordinating of exhibits of the same class. Grouping of allied products in this way will give a better picture, allow more time in the desired zones, and eliminate the time wasted in needless search.

The present ideas of exhibitors at the Chicago Show seem to favor the showing of machinery in actual operation, the motored type of equipment prevailing, owing to the ease of operation. Fuel burning also promises to make a display of large proportions. Pump exhibits and equipment in this class will be numerous and there will be ample opportunity for a study of lubrication and specialties pertaining thereto. Progress in boiler design will be shown. A special section is being planned for transmission equipment. Heating and ventilating displays will be more numerous than in previous shows and will bring out the rapid progress that is being made in this field.

Although it always has been a medium for betterment in the power industry, it is evident that the 1929 show will be more instructive and of greater value than any previous show.

F. P. McKibben to Give Lectures on Welded Buildings

A lecture tour covering a large part of the United States is being made by Prof. Frank P. McKibben, well-known consulting structural and bridge engineer, in response to invitations from various societies throughout the country. The lectures during the winter months will be on the application of electric arc welding to the noiseless construction of buildings, based on the experience of the General Electric Company and other pioneers in this field.

Professor McKibben's itinerary, which is as yet incomplete, is comprised of addresses to be delivered before the local sections of the national engineering scoieties, as well as many other smaller engineering organizations. He expects to cover the United States and to deliver his lecture in several large Canadian cities also.

Society Affairs

Providence Engineering Society, Providence, R. I.—The designing and drafting sections of the society will meet on Tuesday, Oct. 28, at 8 p.m. The subject to be discussed will be "The Diesel Engine."

A.I.E.E.—The Regional Meeting of the Southern District will be held at Atlanta, Ga., Oct. 29-31. O. O. Rae, 426 Marietta St., Atlanta, heads the registration committee.

A.S.M.E., Dayton, Ohio, section, will hold a meeting on Oct. 24 at the Engineers' Club of Dayton. The speaker will be Alex Dow, president of the national society. Mr. Dow will give an informal talk on a subject which has not yet been announced.

Coming Conventions

American Institute of Electrical Engineers, annual winter convention, New York City, Jan. 28-Feb. 1; annual summer convention, Swampscott, Mass., June 24-28; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Institute of Refrigeration, at Washington, May, 1929. Louis Baron, secretary, 203 West 13th St., New York City.

American Society of Refrigerating Engineers, at New York City, Dec. 2-6, 1928. David S. Fiske, secretary, 37 West 39th St., New York City.

American Refractories Institute, fall meeting, New York City, Oct. 24, D. A. Texter, secretary, 2202 Oliver Building, Pittsburgh, Pa.

Master Boiler Makers Association, at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 12-16; G. E. Pfisterer, secretary, 53 West Jackson Blvd., Chicago.

National Association Practical Refrigerating Engineers, annual convention at Louisville, Kentucky, Nov. 20-23; E. H. Fox, secretary, 5707 West Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering will be held at the Grand Central Palace, New York City, Dec. 3-8. Address inquiries to the International Exposition Company, Grand Central Palace, New York City.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Second Bituminous Coal Conference will be held at Pittsburgh, Nov. 19-22.

Obituary

Robert V. Prather, Secretary of the Great Lakes Division of the National Electric Light Association, died suddenly Sunday morning, Oct. 7, in St. Louis, from a cerebral hemorrhage. His death deprives the industry of one of its best known executives. He was also secretary and treasurer of the Illinois State Electric Association, Illinois Gas Association and Illinois Electric Railways Association.

Born Jan. 28, 1884, in Claremont, Illinois, Mr. Prather spent most of his life in the electric light and power industry in the Middle West. In 1914 he was appointed secretary of the Illinois Public Utilities Association by Governor Dunn and since that time has made his home in Springfield. Resigning from the Public Utilities Commission in 1918, Mr. Prather devoted his energies to combining the three associations representing the gas, electric and railway industries. He was made secretary of all three associations. Under his direction one joint convention has been held each year since the consolidation.

In addition to his executive work for the association in Illinois, Mr. Prather and Ben Lyons purchased the Kewanee Public Service Company and operated it for some time before selling it to the Illinois Power & Light Corporation.

Personals

L. W. Wade, former treasurer of the Iowa Public Service Company, has been advanced to vice-president, and W. N. Porter, former secretary, becomes secretary and treasurer of the Iowa Public Service through reorganization of the utilities concern effected last week upon removal of its headquarters from Ft. Dodge to Sioux City, where it occupies the building at 515-517 Fifth St. Don M. Sterns, president of this company, becomes head of its subsidiaries, the Sioux City Gas & Electric and Sioux City Service companies. G. A. Neal, continues as vice-president in charge of operations; and R. B. Searing, former secretary of the Sioux City Gas & Electric, is made assistant secretary-treasurer, retaining his duties as assistant secretary to the two utilities. W. J. Bertke, former president of the Sioux City Gas & Electric, becomes vice-president and general manager of the Sioux City subsidiaries, and E. L. Kirk former head of the Sioux City Service, becomes first vice-president and manager of the Sioux City Service, operating the traction service.

H. R. Sterret, formerly president of the Des Moines (Iowa) Gas Company, has been appointed regional vice-president of the Philadelphia Suburban Counties Gas & Electric Company, in charge of electric and gas operations in the main line division, with headquarters at Ardmore, Pa.

G. M. Jackson, president and general manager of the Jackson Engineering & Equipment Company, of Los Angeles, Calif., has returned to that city following a trip through the Central and Southern States lasting several weeks.

M. C. Rhodes, formerly in the engineering department of the Riley Stoker Corporation, Worcester, Mass., is now employed by the Standard Power Equipment Corporation, St. Louis, Mo., as manager of its mechanical department.

Arthur H. Tweedie, Hamilton, Ontario, has been appointed to the position of superintendent of the new power plant of the St. John River Power Company at Grand Falls, N. B.

B. H. Snow, of the Bernitz Furnace Appliance Company, Boston, Mass., spoke before the Plant Engineers' Club at the first meeting of the season of 1928-29 at the Boston City Club, Oct. 17. He illustrated the manufacture

and application of carborundum both as an abrasive and as a refractory, with an industrial film of 4½ reels, shown through the courtesy of Carborundum Company and the Bernitz Furnace Appliance Company.

Business Notes

The W. C. West Company, of Chicago, Ill., announces that it is now represented in the New York territory by C. N. Shaffner, 110 East 42nd St., New York City, and in the Cleveland territory by the Craun-Liebing Company, 30 Euclid Arcade Annex, Cleveland.

The Chicago Pump Company, Chicago, Ill., announces that on Sept. 15 its New Orleans territory was taken over by H. J. Kelly, with offices in the Louisiana Building, New Orleans.

The Julian D'Este Company, Boston, Mass., announces that it has appointed W. A. Viets advisory engineer, to take charge of the sales of its Curtis Type T return trap. Mr. Viets will make his headquarters at Dayton, Ohio.

The Pacific Engineering Company was incorporated in Portland, Ore., Oct 1, for the purpose of conducting a contracting and consulting business. Members of the firm are C. A. Alphonse, Roy Ames and F. E. Westfall.

The Peabody Engineering Corporation, of New York City, has appointed Walter Castanedo, Inc., 1115 Maritime Building, New Orleans, La., as its agent in Louisiana and Mississippi.

The Whiting Corporation, Harvey, Ill., announces the appointment of the D. S. Mair Machinery Company, of Houston, Texas, as its agents in that state. The Mair company will handle the complete Whiting and Swenson lines of cranes, foundry equipment and railway specialties.

The C. & G. Cooper Company, Mt. Vernon, Ohio, announces that it has purchased the manufacturing department of the Hope Engineering Company, also of Mt. Vernon. The purchase includes the Hope factory, plant site and engine designs. The Hope line of vertical gas engines and compressors will be added to the list of Cooper products, which heretofore has consisted only of the slow-speed horizontal types, chiefly in the larger sizes.

The Magnetic Manufacturing Company, Milwaukee, Wis., announce the appointment of George F. Joyce as assistant sales manager for Chicago and vicinity. The office in this city has been moved to new and larger quarters at 720 Cass St.

The General Electric Company announces that orders received during the quarter ended Sept. 30, 1928, amounted to $90,328,666, as compared with $77,420,263, the figure obtaining for a similar period during 1927.

Trade Catalogs

The Bristol Company, Waterbury, Conn., has just issued a new catalog, No. 1900, comprising 24 pages of descriptive matter and illustrations dealing with long-distance transmitting and recording systems. The catalog is unusually complete, since it gives diagrams and illustrations covering all phases of distance recording meters, as well as numerous reproductions of charts, scale calibrations, etc. Typical uses of the long-distance system are discussed in the back pages, and a listing is made of all accessory equipment needed.

Synchronous Condensers—Leaflet No. 20369, issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., gives a brief description in text and pictures of salient features of the Westinghouse synchronous condensers in large sizes.

Semi-Diesel Engines—The Chicago Pneumatic Tool Company, Chicago, Ill., in Bulletin 773 describes its semi-Diesel gas engines for stationary installation. The publication contains 12 pages of illustrations and descriptive matter.

Water Level Indicator—Julien P. Friez & Sons, Baltimore, Md., has issued a four-page bulletin describing the Au water-level indicator. This device is designed to transmit water-level readings to remote points.

Pulverized Coal Firing—"Turbulent Burning" is the title of a loose-leaf booklet of bulletins recently made up by the Fuller Lehigh Company, Fullerton, Pa., and illustrating the use of pulverized-fuel burning equipment and pulverizers.

Multi-Jet Condensers — Bulletin No. 5-A, recently issued by the Schutte & Koerting Company, Philadelphia, Pa., discusses in 32 pages their low-level multi-jet condensers. A very complete description of the product is given in this publication and there are numerous illustrations in colors to assist the reader in tracing the flow of the fluids through the apparatus. Two pages of steam tables are included in the back of the bulletin.

Three-way Valves—Pamphlet No. 350, just issued by the Semet-Solvay Engineering Corporation, gives a brief description of the Steere 3-way backrun valve as used in the Steere water gas machine.

Resistance Measuring Instruments—Bulletin 1200, just issued by the James G. Biddle Company, Philadelphia, Pa., is entitled "Megger and Meg Direct-Reading Ohmmeters." In 16 pages of text and illustration it shows the various styles of Biddle high-resistance measuring instruments and gives much useful data on applications.

Valves — The Merco Nordstrom Valve Company, San Francisco, Calif., has just issued Catalog No. 6, covering the subject of valves in a thorough manner. So complete is the catalog that it approaches a handbook in scope. There are 142 pages of descriptive matter, tables, installation photographs, phantom views and diagrams. A section of the publication is devoted to service cocks and another to accessories and parts for all Nordstrom valves.

Automatic Operation—For synchronous converters in mining service, is a subject touched upon by Bulletin GEA-572A, issued by the General Electric Company, Schenectady, N. Y. In the four pages presented, some general considerations are discussed, and a diagram is included which demonstrates the method of control.

Small Steam Turbines—An eight-page bulletin, No. 135-4, has just been issued by the Coppus Engineering Corporation, of Worcester, Mass., describing its Type TF steam turbines, in ratings from 1 to 60 hp. Dimension diagrams, horsepower and water-rate curves are given, together with a short description.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.25@$2.50
Kanawha	Columbus	1.35@ 1.75
Smokeless	Cincinnati	2.25
Smokeless	Chicago	1.90@ 2.25
S. E. Kentucky	Chicago	1.40@ 1.95
Steam	Pittsburgh	1.60@ 1.80
Gas Slack	Pittsburgh	1.00@ 1.20
Big Seam	Birmingham	1.25@ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.85@$3.25
Barley	New York	1.30@ 1.75

FUEL OIL

New York—Oct. 18, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4¾c. per gal.; 36@40 deg., furnace, tank-car lots, 6½c. per gal.

St. Louis—Oct. 16, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.37½ per bbl. or 42 gal.; 26@28 deg., $1.42½ per bbl.; 28@30 deg., $1.47½ per bbl.; 30@32 deg., $1.52½ per bbl.; 32@36 deg., gas oil, 4.3c. per gal.; 38@40 deg., 5¼c. per gal.

Pittsburgh—Oct. 16, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5¼c. per gal.

Philadelphia—Oct. 13, 26@30 deg., $1.89@$1.96 per bbl. or 42 gal.; 13@19 deg., $0.95@$1.02 per bbl.; 22 plus. $1.43@$1.50 per bbl.; 27@30 deg., $2.00@$2.07 per bbl.

Cincinnati—Oct. 16, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5¼c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Oct. 13, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 57½@ 60c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., 95c. per bbl.

Boston—Oct. 15, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.5c. per gal.; 28@32 deg., 5.6c. per gal.

Dallas—Oct. 13, f.o.b. local refinery, 26@30 deg., $1.15 per bbl. or 42 gallons

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Sacramento — California Counties Development Corp., Los Angeles, has been granted permit for diversion of 220 cu.ft. of water per sec. from Yuba River for power and irrigation purposes. Estimated cost $400,000.

Calif., Sacramento — Imperial Irrigation District, El Centro, has been granted permission to hold election for purpose of voting $2,100,000 bonds for the construction of six power plants here on canals of the district. Private plans.

Ind., Columbia City—City, L. L. Essig, Clk., awarded contract for the construction of a power plant, and pump house, including turbine, and water softener, to G. A. Walters. Estimated cost $45,000.

Ind., Hobart—City is having preliminary plans prepared for the construction of a water and light plant. Burns & McDonnell Engineering Co., 401 Institute Bldg., Kansas City, Mo., is engineer.

La., Oakdale—Louisiana Public Utilities Co., subsidiary of American Utilities Co., 600 North Second St., Harrisburg, Pa., plans rebuilding power plant and installing internal combustion engines to supply power to Oberlin and Kinder, La.

Mass., Boston—Dept. of Public Buildings, J. P. Englert, Comr., will soon award contract for the completion of power house and heating plant at Charles St. jail. Desmond & Lord, 1 Beacon St., are engineers.

Mass., Foxboro—Dept. of Mental Diseases, State House, will build addition to power house at State Hospital by day labor. Estimated cost $40,000. McLaughlin & Burr, 88 Tremont St., Boston, are engineers.

N. J., West New York—Ideal Laundry Co., Palisade Ave., will soon award contract for the construction of a boiler house and power house. Estimated cost $40,000. J. J. Gloster, 1440 Broadway, New York, N. Y., is architect.

N. Y., New York—Manhattan Refrigerating Co., T. A. Adams, Pres., 525 West St., is having sketches made for the construction of addition to refrigeration plant at 533 West St. Estimated cost $100,000. G. Aus, 244 Madison Ave., is engineer.

O., Rocky River (br. Cleveland)—R. A. Teshera, 19520 Frazier Dr., plans the construction of an 8 story apartment hotel, including steam heating and refrigeration systems, boilers, elevators, etc. Estimated cost $1,000,000. W. S. Ferguson Co., 1900 Euclid Bldg., Cleveland, is architect.

Tex., Conroe—Gulf States Utilities Co., Beaumont, plans the construction of a high line from Conroe to Navasota, a distance of 40 mi. to include sub-station. Estimated cost $70,000. Private plans.

Tex., Donno—T. W. Hooks, et al., plan the construction of a dam, 16,400 ft. long on the Frio River to impound 60,000 acre ft. of water for power and irrigation purposes. Estimated cost $150,000. Private plans.

Tex., Laguna Vista—Dixie Development Co., A. R. Jones, Pres., 900 Land Bank Bldg., Kansas City, Mo., is receiving bids for the construction of three pumping plants, including a river pump, etc. in connection with irrigation project.

Tex., Point Isabel — Cameron County Water Improvement Dist. 14, Brownsville, is having tentative plans prepared for irrigation project including pumping plants, pumps, etc., here. Estimated cost $160,000. W. E. Anderson, San Benito, is engineer.

Tex., Temple—T. V. Lawson, 236 Cumberland St., San Antonio, awarded contract for the construction of a 40 ton ice plant, electrically operated here, to Love Construction Co., Temple. Estimated cost including equipment $40,000.

Wash., Seattle—Puget Sound Power & Light Co., W. H. McGrath, V. Pres. Stuart Bldg., awarded contract for the construction of a steam power plant on Lake Washington to Stone & Webster Inc., Stuart Bldg. Estimated cost approximately $5,000,000. The first unit will be a 35,000 kw. generating plant and it is ultimately planned to develop six such plants with an ultimate total cost of $25,000,000. Boilers will operate under 450 lb. steam pressure, designed to burn coal, oil or hogged fuel.

B. C., Point Grey—British Columbia Electric Railway Co., 425 Carrall St., Vancouver, has approved estimates for enlargement of existing sub-station including 6,000 kw. transformers, four high tension oil circuit breakers, etc., here. Estimated cost $140,000.

Ont., Orillia—City Council plans an election Jan. 1 to vote on bylaw for extensions and improvements to sewage system including sewage pumping station at James and West St. S., and sub-sewage pumping station at Elgin St. Estimated cost $65,000. Gore, Nasmith & Storrie, Confederation Life Bldg., Toronto, are engineers.

Ont., Port Colborne—City Council, H. F. Johnson, Clk., will soon award contract for the construction of a sewage system including pumping stations, vertical pumps and motors, etc. Estimated cost $75,000. Waynne Roberts Son & McLean, 44 Victoria St., Toronto, are engineers.

Spain—Segura & Jugar Hydro-Electric Development Co. awarded contract for the construction of five 20,000 kw. hydro-electric plants on the Segura and Jugar Rivers in southeastern Spain to Fox Bros. International Corp., 33 Rector St., New York, N. Y. Estimated cost approximately $20,000,000.

Equipment Wanted

Boiler—City of Brownsville, Tex., plans to purchase boiler for light plant. $60,000.

Generators—City of Winnipeg, Man., M. Peterson, City Hall, Clk., will receive bids until Nov. 19 for two 10,000 and two 450 kva. generators complete with accessories and spare parts at Slave Falls, Man.

Generators, etc. — Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until Nov. 7 for generator, switchboard panel and accessories, also soon takes bids for 150 kw. engine driven d.c. generator, switchboard panel and accessories at Naval Hospital, Norfolk, Va.

Ice Plant and Power Plant Equipment—City of Denton, Tex., will soon receive bids for ice plant equipment including 350 hp. gas engine, 312 kva. generator, 2,000 g.p.m. centrifugal pump with motor and two 25 ton units for ice plant, also receiving bids for power plant equipment, including pump, etc. $27,000.

Pumping Equipment—City Comrs. of Mobile, Ala., will receive bids until Oct. 26 for removal of steam units and installation of two 5,200 g.p.m. 200 ft. head, dual driven synchronous motor and gasoline engine and horizontal centrifugal pumps in Bienville pumping station; one 5,200 g.p.m. 170 ft. head dual driven synchronous motor and gasoline engine and horizontal centrifugal pump and one 400 g.p.m. 350 ft. head, dual drive induction motor and gasoline engine and horizontal centrifugal pump in Spring Hill pumping station; one 5,200 g.p.m. 30 ft. head dual drive, induction motor and gasoline engine and horizontal centrifugal pump in Spring Hill booster pumping station.

Pumping Equipment—City of Dalworth, Park, Tex., will receive bids until Oct. 26 for pumping equipment for proposed waterworks improvements. Estimated cost $40,000.

Pumping Units, etc.—City of Memphis, Tenn., J. Sheahan, Gen. Supt., will receive bids until Nov. 7 for one 15 m.g.d. steam turbine, reduction gear driven centrifugal pumping unit and condensing auxiliaries and one 1 m.g.d. secondary hydraulic driven pumping unit for proposed waterworks improvements.

Pumps and Motors — Merced Irrigation Dist., Merced, Calif., H. P. Sargent, Secy., will receive bids until Oct. 30 for ten drainage pumps and motors complete.

Refrigerating Display Cases, etc.—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until Nov. 14, for refrigerating display cases and machine for Naval Operating Base (supply depot), San Diego, Calif.

Switchboard—City of Independence, Mo., plans to purchase (later) switchboard for proposed addition to power plant.

Industrial Projects

Conn., West Haven—TEXTILE PLANT—Velvet Textile Corp., Gilbert St., is having plans prepared for a 1 story, 45 x 152 ft. weaving building for textile plant. Estimated cost $40,000. D. E. Smith, 52 Temple St., New Haven, is architect.

Mass., Newton (Boston P. O.) — FAN FACTORY—Davidson Fan Co., 15 Brook St., awarded contract for a 2 story, 50 x 100 ft. factory on California St., to John MacDonald Construction Co., 250 Stuart St.

Mass., Somerville (Boston P. O.)—FACTORY — Vacuum Co., 105 Mystic Ave., awarded contract for addition to factory, to J. W. Bishop Co., 100 Erie St., Cambridge. Estimated cost $100,000.

Mich., Battle Creek—THRESHING MACHINE FACTORY—Nicols & Shepard Co., will soon award contract for a 1 story, 100 x 400, 88 x 100 and 58 x 100 ft. factory on Marshall St. Estimated cost $275,000. A. Kahn, 1,000 Marquette Bldg., is architect. Equipment will be required.

Mich., Detroit — AUTOMOBIBLE BODY FACTORY—Briggs Mfg. Co., 11631 Mack Ave., awarded contract for a 1 story, 140 x 370 ft. building for finishing automobile bodies, on Warren Ave., to Otto Misch Co., 159 East Columbia St. Estimated cost $80,000.

Mich., Detroit—BODY FACTORY—Fisher Body Corp., General Motors Bldg., is having plans prepared for a 1 and 3 story, 100 x 600 ft. factory on Beaubien St. Private plans. Equipment will be required.

Mich., Detroit — AUTOMOBILE FACTORY ADDITION — Chrysler Motor Car Corp., 341 Massachusetts Ave., Highland Park, awarded contract for a 4 story, 50 x 120 ft. addition to automobile plant on East Jefferson Ave., to R. H. Hidey, General Motors Bldg. Estimated cost $50,000.

Mich., Detroit — AUTOMOBILE PARTS FACTORY—Pollmar & Ropes, 2539 Woodward Ave., Archts., will receive bids about Oct. 23, for a 1 story factory for Liberty Starter Co., 241 Minnie St. Estimated cost $50,000.

N. Y., Tonawanda—AIRPLANE FACTORY—Curtiss Airplane & Motor Co., 74 Kail St., Buffalo, awarded contract for a 60 x 200 and 200 x 1,500 ft. factory here to J. Stuart & Co., 17 East 42nd St., New York, N. Y. Estimated cost $3,000,000.

N. C., Asheville—RAYON PLANT—American Enka Corp., A. F. L. Moritz, V. Pres. and Ch. Engr., 114 East 32nd St., New York, N. Y., awarded contract for the construction of a rayon plant in Hominy Creek Valley here to H. K. Ferguson, Co., Hanna Bldg., Cleveland, O. Estimated cost approximately $10,000,000.

O., Dayton—SHOCK ABSORBER FACTORY — Delco-Remy Co., 329 East First St. (subsidiary of General Motors Corp.), awarded contract for a 1 story, 75 x 120 ft. factory on First St. to Hillsmith & Co., Winters Bank Bldg. Estimated cost $50,000.

O., Cleveland—FOUNDRY—Forest City Walworth Run Foundries Co., W. J. Strangward, Pres., 2500 West 27th St., awarded contract for rebuilding 4 story foundry at West 27th St. and Nickel Plate R.R., destroyed by fire, to S. W. Emerson Co., 1836 Euclid Ave. Estimated cost $50,000.

Tex., Port Aransas—CEMENT and PAVING MATERIAL PLANT—Monolith Portland Cement Co. will soon receive bids for the construction of a cement and paving material plant. Estimated total cost $2,500,000. Private plans.

Tex., San Antonio—BASKET and CRATE FACTORY—M. A. Childero, et al, City National Bank Bldg., San Antonio, Tex., plans the construction of a basket and crate factory. Estimated cost $150,000. Machinery and equipment will be required.

Wash., Seattle — FROG and SWITCH MANUFACTURING PLANT — Ramapago Ajax Corp. plans the construction of a 110 x 200 ft. frog and switch manufacturing plant at First Ave. S. and Hudson St. Estimated cost $400,000. Racor Pacific Frog & Switch Co. is lessee.